DOCUMENT RESUME

ED 230 557 TM 820 262

AUTHOR	Harris, Chester W.; And Others
TITLE	Studies of Domain Referenced Item Models. Final Report. Volume 1: Sections I and II.
INSTITUTION	California Univ., Santa Barbara.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC. Teaching and Learning Program.
PUB DATE	15 Jul 80
GRANT	NIE-G-78-0085
NOTE	257p.; Document contains small print throughout. For related document, see TM 820 263
PUB TYPE	Reports - Research/Technical (143) -- Statistical Data (110)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Achievement Tests; Classroom Research; *Difficulty Level; Elementary Education; Estimation (Mathematics); Instructional Materials; Latent Trait Theory; *Maximum Likelihood Statistics; *Models; Sampling; *Test Items
IDENTIFIERS	Monte Carlo Studies

ABSTRACT

The first section of this two-volume report describes a point of view about testing in connection with classroom instruction. A model was developed, based on this point of view, postulating a generic task (such as addition of two-digit numbers). A random sampling principle was used to generate sample items, the performance on which gives an unbiased estimate of the proportion of items in the universe that can be answered correctly by the examinee. For generic tasks that involve completion and/or short answers that are constructed by the examinee, an item model is specified that relates performance on a particular item to a two-category latent class variable. Item difficulty is seen to be a product of two terms, one describing the "easiness" of the generic task, and the other describing the easiness of the particular content embedded in the item. Four methods of estimation of these parameters are described in Section II. On the basis of a Monte Carlo study, Goodman's maximum likelihood method is recommended. (PN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

STUDIES OF DOMAIN-REFERENCED ITEM MODELS

UNIVERSITY OF CALIFORNIA
SANTA BARBARA, CALIFORNIA

Grant No. NIE-G-78-0085, [illegible]

Submitted to National Institute of Education
by Chester W. Harris, Principal Investigator

July 15, 1980

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

NATIONAL INSTITUTE OF EDUCATION
Program on Teaching and Learning

Grant No. NIE-G-78-0085

Project No. 8-0244

Final Report

July 1, 1980

Prepared by Chester W. Harris, Richard T. Houang, Andrea Pastorok Pearlman
and Bruce Barnett

This report describes our notions about the measurement of achievement, and our notions of subject-matter domains and item universes and ways in which item universes might be characterized--all leading to the achievement item model which we are studying. In addition this report describes uses of this achievement item model within classrooms in the middle elementary grades in several schools. A major technical problem is that of estimation of the parameters that are assumed to characterize our achievement item model. We describe four methods of estimation that are relevant and appear to exhaust the possibilities now evident in the literature. These four estimation methods become the methods used in our simulation studies and in the analysis of the actual classroom data that has been gathered.

Grant No. NIE-G-78-0085
Project No. 8-0244
Final Report

ABSTRACT

A point of view about achievement testing in relation to an instructional program regards the measurement of achievement as critical in any teaching-learning situation. The purpose of the instruction, expressed in terms of objectives, provides a basis for the development of the achievement measures, as well as a basis for the selection and organization of the content and teaching materials. The content of an instructional program is viewed as a conceptually homogeneous set of particulars, such as a set of terms, a set of principles, a set of problems, that are to be learned. A generic task is associated with the content, and achievement tests can be constructed by means of an item form. This permits the explicit or implicit definition of an item universe and the selection of a random sample of test items by sampling the content domain. Performance on such a sample of items provides an unbiased estimate of the student's achievement with respect to the entire item universe.

For generic tasks that involve completion and/or short answers that are constructed by the examinee, we specify an item model that relates performance on a particular item to a two-category latent class variable, and then use this model to develop the expected relation between replicates of that item, and the relation between two such items drawn from the same universe. Item difficulty is seen to be a product of two terms, one describing the "easiness" of the generic task, and the other describing the easiness of the particular content embedded in the item. Four methods of estimation of these parameters are described, and on the basis of a Monte Carlo study Goodman's maximum likelihood method is recommended. Experience in using this teaching-testing system in several classrooms is described, as well as data gathered over a period of a year and a half. Abstracts of related research studies are presented.

SECTION I

Contents

Page

A Point of View about Achievement 1

The Measurement of Achievement 2

A Primitive Item Model 5

A Stability Model 8

An Equivalence Model 10

Aspects of Reliability 12

References for Section I 18

Table 1. Selected Indices of Agreement and Association 16

Figure 1. Joint Distribution of a Dichotomously Scored Production Task and a Dichotomous Latent Class 7

Figure 2. Joint Distribution of the Same Production Task Administered Twice 9

Figure 3. Joint Distribution of Two Different Performance Tasks 11

SECTION I

A point of view about achievement. This report focuses on the construction and study of a particular type of achievement testing procedure. In leading up to these topics we first wish to comment on achievement and the measurement of achievement in the context of an instructional program.

We conceive of achievement as a construct that differs from the construct of ability. First of all, common usage of the terms tends to imply that achievement with respect to some particular signifies a state that has been reached (or at least partially reached), and that it supplants or succeeds a prior state of lesser or quite possibly no achievement with respect to this particular. In contrast, ability often implies a potentiality--quite possibly latent or inchoate--that has existed over some time even though not made manifest, and is likely to continue to exist in the future. This distinction is consistent with the standard definition of achievement quotient as "a measure indicating how a child's actual achievement compares with his ability." The term achievement also is often associated with instruction, either formal or informal. Thus we usually think that for achievement to result, there must be some kind of learning, some kind of practice. Within the enterprise of formal education, the assumption is often made that certain achievements can be brought about in the students who are the clients of the education enterprise, and that the plans, resources, and activities associated with the school are related to this learning or development or manifestation of achievement. Whether or not ability is modified by instruction is a question that can prompt lengthy semantic disputes.

It seems reasonable to believe for a given student both that an instructional program may have been critical in promoting certain of the student's achievements and also that not all his or her achievements may have been learned in that program--possibly not even in school. Since our interest is in methods of measuring achievement in the context of an instructional program, we shall be concerned with instructional situations in which students are being taught something relatively new (to them). Early in the course of this instruction the expectation quite well may be that very few or none of the students will demonstrate the achievement which is the desired objective of the instruction. However, as instruction proceeds the expectation should change, and the achievement measures should document this change for the various individuals. Note that we might expect a conventional measure of ability or capacity not to change markedly for any student--especially during a relatively short period.

We are concerned then with the measurement of achievement in the context of an instructional program. We shall define a type of achievement as being implied or suggested by an objective of the instructional program, and we shall suggest one way of translating and/or fleshing out this objective to provide a basis for developing achievement measures. We shall be concerned about an objective of the instructional program in a generic sense, and so we shall adopt a method of selecting items for tests that permits for any examinee a standard inference about the examinee's performance on the item universe. We shall be concerned with change in test performance associated with instruction and so we shall propose a method of analyzing data that focuses on changes in achievement during instruction. In following this path we shall encounter technical problems that will send us to earlier work by a number of people. Clearly, much of what we present here cannot be called "new"; however, we hope that what we present has a coherence that advances some of the earlier discussion of achievement testing.

The measurement of achievement. We begin by stating our assumption that the measurement of achievement is an important--in fact critical--activity in the teaching of students. We will not argue here such issues as whether measurement should be formal or informal, whether it should be "subjective" or "objective," whether it should be norm referenced or criterion referenced, etc. Instead we shall argue that any activity that involves a teacher plus one or more students and is intended to be a teaching activity should include some provision for the measurement of student achievement. The immediate utility of the results of such measurement can be twofold: (1) the provision of information for the student that will enable the student to monitor his or her own progress or learning; and (2) the provision of information for the teacher that will enable the teacher to judge at least some aspects of the success of the teaching, to plan remedial activities, and to plan new teaching activities that can logically grow out of the current state of learning. There can be other, less immediate utilities also. For example, these may be related to administrative decisions about retention and reward of teachers, or about the plans and purposes and/or the equipment and materials of the school. We here, however, are concerned primarily with the utilities we have labeled immediate.

We conceive of a teaching-testing complex, where the term testing must be given a broad interpretation as an appropriate information gathering procedure, rather than a narrow interpretation as a particular kind of device. This complex is assumed to be characterized by plans and purposes--often stated in the form of objectives--that serve two functions. For one, they provide a basis for selecting and/or constructing appropriate instructional procedures and materials; for a second, they provide a basis for developing a definition of the evidence of achievement that will be accepted for those particular instructional activities. At least for some teaching-testing complexes it is possible to define a domain of content, such as a domain of concepts, a domain of terms, a domain of problems, etc.; such a domain constitutes the content to be learned in the instructional program. It is desirable that the domain of content be characterized by conceptual homogeneity; this is to say that an instructional program with a given objective has little coherence unless the content to be learned represents instances of some class or domain. Thus in schools we may try to promote knowledge of forms of government, knowledge of types of poetry, or the like, in each instance conceiving of a homogeneous (organized) body of content to be learned. Similarly with skills, we conceive of a set of English words, the spelling of which is to be learned; or we conceive of a type of arithmetic or algebra problem, the solution of which is to be learned. Clearly, teaching involves dealing with the particulars of any domain; however it also is true that it is knowledge of or skill with the domain of content that constitutes the desired end result of the instruction. A school teaches particulars, but it is the generalization of the performance to the entire domain of content that is desired. We shall use the term "generic task" in this connection.

Let us now illustrate a method of measuring achievement that depends upon the existence of a domain of content plus the association with this domain of content of a generic task, the successful performance of which is believed to constitute evidence of achievement. We use Ebel's (1962) Content Standard Test Scores as the illustration.

Ebel in effect defined as a domain of content the words appearing in a specific English dictionary, and he defined as a task the recognition of a definition of the word drawn from the same dictionary. He then used a "spaced" sampling procedure to select a sample of words from this corpus, presented the words along with the definitions presented in a scrambled order, and had examinees select a correct definition for each word in the sample. The proportion of correct answers by an examinee was taken as an estimate of the proportion of words in the dictionary with which that examinee was familiar enough to identify their correct definitions. We hasten to add that a different generic task might have been chosen, such as producing a definition for the word; this would have changed (from recognition to recall, e.g.) the evidence of achievement or "knowing" that would be accepted.

The structure of this procedure of Ebel's seems to us to require a domain of content (the words) and an associated generic task (recognition of definitions) which together permit the construction of an m-item test by simply sampling the words and their associated definitions and presenting these two lists (with the second list in scrambled order) to examinees. The task in this instance is a matching task, and the raw score is the number of correct matches. With a random sampling of the words to be tested, this score when turned into a proportion is an unbiased estimate of the proportion of correct matches the examinee could have made were it possible to respond to all the words in the domain.

It is well known that random sampling from a two-valued distribution guarantees that the observed proportion for a sample of size m is an unbiased estimate of the proportion in the population, which is a parameter of the binomial distribution. This testing situation can fit this model. For any examinee there is an implicit two-valued distribution of correct and incorrect answers to all of the words in the dictionary; the proportion correct is a parameter for the examinee (π_i). Selecting randomly m items with which to test the examinee permits an observation of a proportion correct on that sample, which is a statistic whose distribution over repeated samples of size m is given by the binomial with mean equal to π_i and variance equal to

$$\frac{(\pi_i)(1 - \pi_i)}{m} .$$

We call a statistic (estimator) for which the mean of its random sampling distribution equals the parameter which that statistic estimates an unbiased estimator. Stratification can also be incorporated into this procedure without doing violence to the unbiased character of the estimator. Thus one could choose random samples separately from sections of the dictionary and create subtests, each of which would provide an unbiased estimate for that section or set of words. These subtest scores could also be combined in meaningful ways to yield other unbiased estimates. The theory of survey statistics deals with unbiased estimation for stratified populations; see for example Cochran (1963).

Ebel's procedure can be interpreted as an anticipation of the work with the item form reported by Hively and his associates (1973). An item form can be thought of as a generic task--the "shell"--incorporating a provision for one or more replacement sets. A replacement set is a (usually) finite set of alternatives any member of which "fits" the task; thus, random selection from the replacement set or sets generates items. An example would be the item shell

$$\begin{array}{rccc} & z & z & z \\ & & z & z \\ + & & z & z \\ \hline \end{array}$$

where each z is to be replaced by a "number" (a digit, say, quite possibly including zero) to yield an addition problem.

For the Ebel example the replacement set consists of pairs of words and definitions, and the generic task is that of matching word and definition when the definitions are in a scrambled order with respect to the words. Given the shell of an item form and the necessary replacement sets, a (finite) universe of items is then at least implicitly available. We note that the addition shell described above provides an item universe of 10,000,000 problems (if we allow zero in any position) and that a random sample of these ten million items can be secured quite readily by randomly assigning the numbers 0, 1, ..., 9 to the spaces in the item shell. Thus, even though one would seldom have all 10 million problems readily available--say in written form--nevertheless the universe of items is implicitly available and can be sampled randomly. We shall use these ideas for the development of item universes in connection with the instruction of students in the elementary grades. All our applications will be in the area of arithmetic instruction. This is a limitation, but it is prudent; the application is rather straightforward and the subject matter (arithmetic) is of considerable importance in today's elementary schools. If we are successful with these applications, we can extend the investigation into other, possibly more difficult, areas.

A primitive item model. We are interested in characteristics of achievement-test items drawn from an item universe where the item universe represents an operational definition of skills and/or knowledges that are intended to be the outcomes of an instructional program. We first will focus on characteristics of single items that fit fairly simple item models for achievement measures, and then we will consider problems of aggregating such characteristics over items in order to derive characterizations of an item domain.

A paper of Shoemaker (1975) ably presents the case for employing item universes and tests made up of random samples of such items in measuring the achievement of students. Such a practice uses a sampling principle to make an unbiased estimate of an examinee's performance on the entire item universe. It is clear that the framework for achievement testing that Shoemaker advocates demands an intimate relationship between the instructional program and the item universe that represents the skills or behaviors to be acquired by the students, and that great care in defining and generating the item universe must be exercised. However, given a conceptually satisfactory item universe, test construction is a matter of randomly selecting items to be administered to a student rather than a matter of item analysis and the selection and rejection of items on the basis of "internal consistency" criteria. This is an important distinction.

Shoemaker's view of an appropriate achievement measure for an examinee is the proportion right score on the entire item universe. Although it is generally unavailable, this proportion right can be estimated unbiasedly and usually can be interpreted for a given examinee without comparing that examinee's score with the scores of other examinees. Thus this item sampling principle can yield achievement tests which are especially suitable for tracking the progress of an individual student as well as a group of students. Randomly equivalent forms of a test can readily be developed without tryout data, the security of test forms is easily maintained by simply creating a new form shortly before it is needed, complaints about "unfair" scores can quickly be settled by creating an alternate form and allowing the examinee to demonstrate on the alternate form a better performance, and "coaching" is no longer a problem since memorization of proper responses to specific items is inadequate to guarantee a "good" score on a different sample of items.

We believe that there is likely to be increased use of domain-referenced achievement tests in classrooms, and we wish to adapt, develop, and study item models that are appropriate for such achievement measures. We are aware that sophisticated and extensive item analysis techniques are available. (See for example the recent review by Baker, 1977. See also Hambleton, et al., 1978.) However, such procedures often focus on particular items rather than on the item domain itself and are directed toward providing rules for accepting (or rejecting) specific items as a part of a test. We shall begin, instead, by regarding a properly developed item universe as an appropriate set of items for measuring achievement in connection with an instructional program, and then attempt to find ways to characterize this item universe by studying particular items. We take the position that no one item or no one small set of items (a "test") is important in itself; the universe is important, and only an estimate of performance on the entire universe is the relevant measure of achievement for an examinee. We believe that Patricia Graham's suggestion for a "national effort to ensure schools have available a wide variety of tests appropriate for the goals and curricula in local situations" (reported in Report on Education Research, Vol. 9, no. 16, August 10, 1977) will be contributed to by our investigations.

We shall be concerned with production items, such as completion or fill-in items for which it is reasonable to believe that it is not possible for an examinee to "guess right." This is a restriction, but it does not exclude a number of test items typically used by teachers in monitoring individual and class achievement. For example, dictated spelling items, column addition in arithmetic, cloze reading exercises in which the examinee supplies the missing word, and the like, are all production items for which our models are appropriate. Our models derive from earlier work of Lazarsfeld and Kendall reported (and modified) by Goodman and Kruskal (1959, pp. 149-152) and further modified by Wilcox (1977).

We first describe a primitive model from which we can develop models for examinee responses to replications of a completion or short-answer item and for examinee responses to pairs of different completion or short-answer items. We postulate an undefined dichotomous latent class with categories designated by (+) and (-); at the moment we do not assign numerical values to these two categories. We assume that some non-zero proportion of the examinee population belongs to the (+) category and the remaining proportion to the (-) category. We assume that a dichotomous completion or short-answer task administered to this examinee population can be responded to correctly only by examinees in the (+) category of the latent trait; in other words we assume that it is not possible to "guess right." However, we permit errors on the part of examinees in the (+) category of the latent class. Figure 1 gives the parameters of the joint distribution of the postulated latent class and a dichotomous production task, with k designating the proportion of examinees in the (+) category of the latent class and x_t (t for task) designating the conditional probability of an error on the task by a member of the (+) category of the latent class.

Joint Distribution of a Dichotomously Scored
Production Task and a Dichotomous Latent Class

		Latent Class		
		+	-	
Production Task	+	$k(1-x_t)$	0	$k - kx_t$
	-	kx_t	1-k	$kx_t + 1 - k$
		k	1-k	1

Figure 1

Note that kx_t is the proportion of examinees who are in the (+) category on the latent trait and respond incorrectly to the task, but that x_t is the conditional probability of this error. A paper by Emrick (1971), which has often been quoted favorably, uses a model which is similar to Figure 1; however, Emrick fails to distinguish between a conditional probability and an unconditional one with the result that his expression for the correlation between the "test" dimension and the latent trait dimension generally is not correct. This point has been documented by Wilcox and Harris (1977). Also note that the zero in the upper right cell of the two-by-two table in Figure 1 makes explicit our restriction to completion or short-answer items for which we assume it is not possible to "guess right." The marginals of Figure 1 for the production task give $(k - kx_t)$ as the proportion correct on the task, or the conventional normative difficulty (actually, "easiness") of the production task or item. This primitive model thus suggests that it may be useful to consider the conventional normative difficulty of a completion or short-answer item as a product of two terms, one of which (k) refers to a proportion of examinees in the (+) category of the latent class and the other of which $(1 - x_t)$ is a conditional probability of such an examinee's being correct on the item or task. If such an analysis can be shown to hold for a domain of items, the k might be taken as a generic index of easiness for the item domain, and $(1 - x_t)$ as a specific index of easiness for item t. One also can speculate that for a given instructional procedure one might observe systematic differences in k and in x_t for a particular item at different points in the instruction, and that different instructional procedures might affect the parameter k and the various parameters x_t in different ways. These are possibilities.

Let us use the conventional scores of 1 and 0 for the correct and incorrect responses to the production task. Then if we also use a scale of 1 and 0 for the (+) and (-) categories of the latent class, this latent class behaves like a Platonic true score. This follows because under these conditions the observed (production task) score minus the true (latent class) score is not generally uncorrelated with the true score. (The covariance is negative.) It also follows that a set of replications of this production task under the ideal conditions of no fundamental change in behavior (no change in k or x_t) will not constitute strictly parallel observations because of this linear dependence between error and true for every observation. See Lord and Novick (1968, pp. 39-44) for a discussion of a single observed variable, and Klein and Cleary (1967) for a discussion of a set of observed variables. Note that we might take $(1 - x_t)$ and 0 as the numerical values for our latent class scale, rather than 1 and 0, and that we then would have defined a difference between the observed score and the rescaled latent class that would be uncorrelated with the rescaled latent class score. This would hold for a set of replications of the production task (with k and x_t constant), and would constitute a congeneric true score. See Werts, Linn, and Joreskog (1973). One can readily verify that for our primitive model the multiplier on the latent class scale should be $(1 - x_t)$ and is simply the regression coefficient specified by Werts, Linn, and Joreskog. One also can verify that for our primitive model the intercept is zero for any and all replicate observations.

A stability model. Let us now use the primitive model to deduce the joint distribution for two replications of the same production task. Again, we specify the ideal condition of no fundamental change in behavior, which can be expressed in the model as no change in k and x_t. The parameters of this joint distribution standardized so that the four frequencies in the two-by-two table sum to unity are given in Figure 2. The model in Figure 2 is identical with Knapp's (1977) model for test-retest of a completion or short-answer item. Knapp also discusses an "index of reliability" for an item. Let us assume that the model holds. The proportion of agreement in Figure 1 equals $1 - kx_t$, and would indicate the proportion of *correct* classifications of examinees by the item on a single administration. The proportion of agreement in Figure 2 equals

$$1 - 2kx_t + 2kx_t^2,$$

and would indicate something slightly different, namely the proportion of *consistent* classifications of examinees by the item on two administrations of the same item. Interestingly, Knapp's measure of "reliability" is a combination of these. He takes $(1 - x_t)^2$ as the reliability of the item for examinees in the (+) category of the latent class. This is, as he points out, simply the ratio of the proportion of examinees who are correct on the item on both occasions to the proportion of examinees who belong to the (+) category on the latent trait. This is his π_1, given that the model holds for a population of examinees who have responded to two administrations of the same item under the condition of no change in behavior for the examinees. Knapp then defines the reliability of the item for the examinee in the (-) category of the latent class as $(1 - k)/(1 - k)$ or unity, and calls this π_0. He then combines

Joint Distribution of the
Same Production Task Administered Twice

		Second Administration		
		+	-	
First Administration	+	$k(1 - x_t)^2$	$kx_t(1 - x_t)$	$k(1 - x_t)$
	-	$kx_t(1 - x_t)$	$kx_t^2 + 1 - k$	$kx_t + 1 - k$
		$k(1 - x_t)$	$kx_t + 1 - k$	1

Figure 2

the two measures with weights k and (1 - k) to secure a linear composite equal to

$$k(1 - x_t)^2 + (1 - k) = 1 - 2kx_t + kx_t^2.$$

Note that this measure reflects the proportion of "consistently correct" classifications and is somewhat smaller than either the proportion of correct classifications or the proportion of consistent classifications when both x_t and k are bounded by zero and unity. Our analysis suggests that for this model these three different measures of agreement can be defined. Their conceptual differences clearly are important; however, it is true that as $\underline{x_t}$ approaches zero, the three converge numerically.

Knapp also illustrates the difference between his reliability index and a measure of association--the product-moment correlation coefficient for binary data (the phi coefficient) applied to sample data for two administrations of the same item. As Knapp properly points out, agreement and association are conceptually different, and one measure may not be a satisfactory substitute for the other. See Harris and Pearlman (1977) for a discussion of a number of measures of agreement and/or association for the joint distribution of two sets of binary data. We can express the phi coefficient for Figure 2 in terms of the parameters k and x_t, thus:

$$\phi_{tt} = \frac{(1 - k)(1 - x_t)}{1 - k(1 - x_t)}$$

Alternatively this phi coefficient for Figure 2 can be expressed as

$$\phi_{tt} = 1 - \frac{x_t}{1 - k(1 - x_t)}$$

which is simply the proportion wrong for the item minus the conditional probability x_t, all divided by the proportion wrong. It is interesting to note that this expression is also a "del" measure for the two-by-two table of Figure 1 in the bivariate prediction model recently developed by Hildebrand, Laing, and Rosenthal (1977, Chapter 3). Knapp's illustrative results which indicate that his index is larger than the phi coefficient can be shown to be the expected result since Knapp's index minus the phi coefficient will always be positive when both x_t and k are bounded by zero and unity. Under these conditions the denominator of ϕ_{tt} is positive, and the numerator of the difference can be shown to be

$$x_t((k^2)(x_t - 2)(x_t - 1) + (1 + kx_t - 2k)),$$

which is zero when $x_t = 0$, but positive otherwise. We also observe that the phi coefficient for Figure 2 is the square of the phi coefficient for Figure 1 as is evident from applying the conventional phi formula to the two figures.

We have here an interesting example. The correlation (phi) of the two measurements is the square of the correlation of either measurement with the undefined latent class. This echoes Lord and Novick (1968, p. 58): "The square of the correlation between observed scores and true is equal to the correlation between parallel measurements." Note however that the replicate observations in Figure 2 cannot be parallel measurements with respect to the Platonic true score given by the latent class scaled 1 and 0, since their errors are not necessarily linearly independent of each other and of the Platonic true score. Thus although parallelmeasurements satisfy this relation between correlation coefficients, the relation itself is not sufficient to guarantee parallel measurements. If however we use the congeneric model for the replications, which in effect in this case scales the latent class as $(1 - x_t)$ and 0, we have linearly independent errors and, as Werts, Linn, and Joreskog point out, we would take the phi coefficient for Figure 2 as the "reliability" of the measurement. This, of course, is the reliability measure which Knapp rejected.

An equivalence model. For two different performance tasks we expect that $x_1 \neq x_2$ generally; however, under certain conditions k my be expected to be the same for both items providing they are administered at approximately the same point in the instruction of the examinees. Suppose, for example, that we have available a well-defined universe of items--especially a universe developed by the use of an item form with fixed portions and one or more replacement schemes that permit random determination of the complete item. If the items in such a universe are modeled by the primitive model of Figure 1, then we can deduce that the joint distribution of any two such items would be represented by Figure 3, in which the parameter k presumably characterizes the generic task and $x_1 \neq x_2$. If the data for a sample of an appropriate population of examinees indicate that the model fits a sample of items from the universe, then one could interpret k as a description of the "easiness" of the task represented by the item form (for that population) and each x_t as a description of the difficulty of the particular replacement sets ("numbers") that appear in the item. Thus for the addition of one

Joint Distribution of
Two Different Performance Tasks

		Performance Task 2		
		+	-	
Performance Task 1	+	$k(1-x_1)(1-x_2)$	$k(1-x_1)x_2$	$k(1-x_1)$
	-	$kx_1(1-x_2)$	$kx_1x_2 + 1 - k$	$kx_1 + 1 - k$
		$k(1-x_2)$	$kx_2 + 1 - k$	1

Figure 3

four-digit and two three-digit numbers, k would describe the "easiness" of this type of addition task for the tested population of examinees and x_1 and x_2 would describe the difficulty of the particular combination of digits appearing in the two items. Again we point out that the conventional normative difficulty of an item is the product of $(1 - x_t)$ and k. This may lead to a useful instructional tool, since estimates of k and x_t could suggest that relatively poor average performance on an item is primarily a function of lack of familiarity with the specific replacement set or instead is primarily a function of unfamiliarity with the generic task represented by the item form. Procedures could then be selected to improve performance by emphasizing the relevant instruction. One might expect, for example, that for column addition, drill on number combinations would primarily affect the values of x_t, whereas instruction with respect to place values and "carrying" would primarily affect the value of k for the entire domain. Investigation along these lines is called for.

Figure 3 is a model for the joint distribution of responses to two different items administered without intervening learning, under the restriction that the items are "equivalent in k," that is, under the restriction that k of the primitive model is the same for both items. Note that the items are not necessarily equal in difficulty, and that this alone is sufficient to indicate that the items are not strictly parallel. Two such items can be members of a congeneric set, however; to see this note that the regression coefficient of item 1 on the 1, 0 latent class (of Figure 1) will be $(1 - x_1)$, for item 2 it will be $(1 - x_2)$, and both intercepts will be zero. If we have a set of such items equivalent in k but different in x_t, then these items should form a matrix of product-moment (phi) correlations which fit the Spearman single general factor model; in other words the items should be a unidimensional congeneric set. This can be verified. The phi coefficient for Figure 3 is:

$$(1)\qquad \frac{(1 - k)((1 - x_1)(1 - x_2))^{1/2}}{((1 - k(1 - x_1))(1 - k(1 - x_2)))^{1/2}}$$

as can be seen by applying the standard computing formula. It then follows that for a set of such items (t = 1, 2, 3, ..., T), the expression in (2) is the general factor coefficient:

$$(2)\qquad \frac{((1 - k)(1 - x_t))^{1/2}}{(1 - k(1 - x_t))^{1/2}}$$

that will generate the correlations; that is, for any two items (say, 1 and 2) the product of the two general factor coefficients will equal the phi coefficient given in (1). Recall that the diagonal entries of a correlation matrix often are taken as unity; for the factor model the factor coefficients reproduce communalities in the diagonal rather than unities.

We can now show that for items that fit the primitive model the joint proportion right for any two items also forms a Spearman matrix. As Figure 3 indicates, the off-diagonal cells of this matrix would be

$$(k)(1 - x_1)(1 - x_2),$$

and so it follows that the column of Spearman coefficients that generate the off-diagonal cells of this matrix are the coefficients

$$k^{1/2}(1 - x_t).$$

We shall use this fact later in our estimation procedures.

One of the standard questions about items and sets of items is the question of their reliability. We turn to some analyses of this concept for our item model.

Aspects of reliability. There are at least three definitions of a reliability coefficient that are commonly referred to within the context of what is often called "classic" test theory. If we separate an observed measurement into a "true" and an "error" portion then it is possible to define as a coefficient the ratio of the variance of the true to the variance of the observed, and under certain circumstances this will equal two other coefficients. If we regard the latent class variable in our primitive model as the "true," then we can write this coefficient in two ways depending upon our notion of the scale used for the latent class variable. If we regard the latent classes as designated by 1 or 0, the ratio of the true variance to the observed variance will be

$$\frac{(k)(1-k)}{(k)(1-x_t)(1-k+kx_t)}$$

or

$$\frac{1-k}{(1-x_t)(1-k+kx_t)}.$$

Recall that this scaling gives a Platonic true score (one for which true and error are not linearly independent); consequently this coefficient will not be equal to a second definition of reliability: namely, the square of the correlation between true and observed. However, if we use the congeneric notion referred to earlier and scale the latent class by $(1 - x_t)$ and 0 (rather than 1 and 0), the variance of the true becomes

$$(k)(1 - k)(1 - x_t)^2$$

and the ratio of true variance to observed variance becomes

$$\frac{(k)(1-k)(1-x_t)^2}{(k)(1-x_t)(1-k+kx_t)}$$

or

$$\frac{(1-k)(1-x_t)}{1-k+kx_t},$$

and this equals the square of the product-moment (phi) correlation for Figure 1.

A third coefficient is the correlation between two "parallel" measurements, which for our model may be taken to be the correlation for Figure 2. We are here defining replications under the condition of no change in k or x_t as parallel measurements for the congeneric model, as do Werts, Linn, and Joreskog (1973). We then recall that we earlier showed that the product-moment (phi) correlation for Figure 2 is the square of the analogous coefficient for Figure 1. Thus we have (a) the ratio of true variance to observed variance, (b) the square of the correlation between true and observed, and (c) the correlation between replications as identical coefficients for our model when we scale the latent class properly. We commented earlier on Knapp's analysis, in which we identified the proportion of correct classifications and the proportion of consistent classifications as related to Knapp's proportion of correct and consistent classifications which he proposed as a "correlationless" approach to reliability. Knapp's work is useful because it reminds us of the distinction between association (e.g., correlation) and agreement and because it shows how the notion of agreement might be utilized at least for one model.

This discussion that relates the three coefficients focuses on the reliability of a single item when our model holds and we adopt the notion of the true score presented in the congeneric model. We also can consider reliability of a score derived from a set of items which might all be administered to the same examinees. Again we assume that our model holds for a population of examinees and describe our results as population reliabilities or estimates expressed in terms of our item parameters. The Kuder Richardson formulas, first presented in 1937, will be used to define estimates (Kuder and Richardson, 1937); these formulas are explicitly for scores derived from sets of binary items and thus are appropriate for our model. It is well known, of course, that work by Hoyt (1941) and Cronbach (1951) presents analyses that are intimately related to Formula 20 of Kuder and Richardson.

First we determine the population correlation between latent class and the raw score given by m replicates of an item under the conditions that the primitive model holds (Figures 1 and 2). In doing this we may take the variance of the latent class variable to be k(1 - k), since the product-moment correlation is scale free. The covariance of the latent class with an item is k(1 - k)(1 - x), where we use no subscript on x because we wish to employ replicates of the same item. The covariance of replicates is $k(1 - k)(1 - x)^2$, and the variance of any replicate is k(1 - x)q, where q = 1 - k(1 - x). It then follows that the desired correlation coefficient is

$$(3) \qquad \frac{((m)(1-k)(1-x))^{1/2}}{((m)(1-k)(1-x) + x)^{1/2}},$$

and we would take the square of this coefficient as an estimate of the reliability of a test made up of m replications of an item. We can now connect this with Kuder-Richardson Formula 2 and Formula 20. A paper by Swinton (1979) reminds us of Formula 2, in which the estimate is the ratio of reliable item variance to total item variance. When we apply this formula to the situation we are discussing, we secure as the reliability estimate the square of the coefficient given in (3). This takes item reliability as the correlation for Figure 2, or the stability coefficient. We also observe that this estimate "obeys" the Spearman-Brown formula; thus if we have 4m replications rather than m replications, the K-R 2 formula would give as the reliability estimate

$$(4) \qquad \frac{4m(1-k)(1-x)}{4m(1-k)(1-x) + x}$$

and this would be equal to the square of (3) stepped up by the general Spearman-Brown formula 4r/(1+3r), where the square of (3) plays the role of r.

We also can show that Kuder-Richardson's Formula 20 gives the square of (3) as the reliability estimate for a test made up of m replicate items. A critical fact here is that all replicates have the same mean and variance. These observations are primarily of abstract interest, since one seldom has tests made up of replicate observations; much more common is the case of tests made up of different items. For m different items that satisfy the primitive model and a population of examinees, we can write

$$(5) \qquad \frac{(1-k)(m - \sum x_t)^2}{(1-k)(m - \sum x_t)^2 + (\sum x_t - \sum x_t^2)}$$

as the K-R 2 coefficient. Here Σx_t designates the summation over the m items of the (different) x_t values; if x_t is a constant for all m items we again have the square of (3). This result can be compared with the K-R 20 formula, which is for m different items.

$$(6) \qquad \frac{m}{m-1} \cdot \frac{(1-k)(m - \sum x_t)^2 - (1-k)(m - 2\sum x_t + \sum x_t^2)}{(1-k)(m - \sum x_t)^2 + (\sum x_t - \sum x_t^2)} .$$

It can be shown that (6) is smaller than (5) for all real values of x_t, and of course that (6) equals unity when every x_t is zero--a case of "perfect" reliability.

It is of interest to look at the abstract structure of items fitting the primitive model in other ways. Harris and Pearlman (1977) review a number of measures of agreement and association for two-by-two tables of binary data, drawing in part on volumes by Bishop, Fienberg, and Holland (1975) and Fleiss (1973). We have selected certain of these measures and expressed them in terms of the item parameters for Figure 1, Figure 2, and Figure 3; these appear in Table 1, with the name of the index and the number of the index taken from Harris and Pearlman. The entries in Table 1 contain some of the indices we have commented on earlier, such as the proportion of correct classifications, the proportion of consistent classifications, and the several phi coefficients. The entries suggest that for the equivalence model (Figure 3) the indices tend to be complicated and thus that no averaging of such an index over item pairs would yield a simple function to use as a descriptor of the item universe. This supports our decision to provide descriptions of an item universe for a population of examinees in terms of estimates of the parameters k and the various values of x_t. We now turn to the problem of making these estimates.

Table 1

Selected Indices of Agreement and Association*

Index	Primitive Model (Figure 1)	Stability Model (Figure 2)	Equivalence Model (Figure 3)
Departure from equal difficulty (1)	kx_t	zero	$k(x_1 - x_2)$
Proportion of agreement (2)	$1 - kx_t$	$1 - 2kx_t + 2kx_t^2$	$1 - kx_1 - kx_2 + 2kx_1x_2$
Observed agreement/ maximum agreement (3)	1	same	Larger of $\frac{1 - kx_1 - kx_2 + 2kx_1x_2}{1 - kx_1 + kx_2}$ and $\frac{1 - kx_1 - kx_2 + 2kx_1x_2}{1 - kx_2 + kx_1}$
Kappa (4)	$\frac{2(1-k)(1-x_t)}{2(1-k)(1-x_t) + x_t}$	$\frac{(1-k)(1-x_t)}{q_t}$	$\frac{2(1-k)(1-x_1)(1-x_2)}{2(1-k)(1-x_1)(1-x_2) + x_1 + x_2 - 2x_1x_2}$
Phi/Phi max (6)	1	same	Larger of $\frac{(1-k)(1-x_1)}{q_1}$ and $\frac{(1-k)(1-x_2)}{q_2}$
Phi (7)	$\frac{((1-k)(1-x_t))^{1/2}}{q_t^{1/2}}$	same	$\frac{(1-k)((1-x_1)(1-x_2))^{1/2}}{(q_1q_2)^{1/2}}$

Table 1 (continued)

Index	Primitive Model (Figure 1)	Stability Model (Figure 2)	Equivalence Model (Figure 3)
Yule's Q (11)	1	$\frac{1 - k}{1 - k + 2kx_t^2}$	$\frac{1 - k}{1 - k + 2kx_1x_2}$
Theta (13)	Either $1 - x_t$ or $\frac{1 - k}{q_t}$	same as Kappa cr Phi	Either $\frac{(1-k)(1-x_1)}{q_2}$ or $\frac{(1-k)(1-x_2)}{q_1}$

* $q_t = 1 - k + kx_t$. "Same" means the same as the entry immediately above in the column.

References for Section I

Baker, F.B. Advances in item analysis. *Review of Educational Research*, 1977, *47*, 151-178.

Bishop, Y.M.M., Fienberg, S.E., and Holland, P.W. *Discrete Multivariate Analysis: Theory and Practice*. Cambridge, Mass.: M.I.T. Press, 1975.

Cochran, W.G. *Sampling Techniques*, Second Edition. New York: Wiley, 1963.

Cronbach, L.J. Coefficient alpha and the internal structure of tests. *Psychometrika*, 1951, *16*, 297-334.

Ebel, R.L. Content standard test scores. *Educational and Psychological Measurement*, 1962, *22*, 15-25.

Emrick, J.A. An evaluation model for mastery testing. *Journal of Educational Measurement*, 1971, *8*, 321-326.

Fleiss, J.L. *Statistical Methods for Rates and Proportions*. New York: Wiley, 1973.

Goodman, L.A., and Kruskal, W.H. Measures of association for cross classifications, II: Further discussion and references. *Journal of the American Statistical Association*. 1959, *54*, 123-163.

Hambleton, R.K., et al. Developments in latent trait theory. *Review of Educational Research*, 1978, *48*, 467-510.

Harris, C.W., and Pearlman, A.P. Conventional significance tests and indices of agreement or association. In C.W. Harris, A.P. Pearlman, and R.R. Wilcox, *Achievement Test Items--Methods of Study*. CSE Monograph Series in Evaluation, No. 6. Los Angeles: Center for the Study of Evaluation, University of California, 1977, pp. 17-44.

Hildebrand, D.K., Laing, J.D., and Rosenthal, H. *Prediction Analysis of Cross Classifications*. New York: Wiley, 1977.

Hively, W., Maxwell, G., Rabehl, G., Sension, D., and Lundin, S. *Domain-Referenced Curriculum Evaluation*. CSE Monograph Series in Evaluation, No. 1. Los Angeles: Center for the Study of Evaluation, University of California, 1973.

Hoyt, C. Test reliability estimated by analysis of variance. *Psychometrika*, 1941, 153-160.

Klein, D.F., and Cleary, T.A. Platonic true score and error in psychiatric ratings. *Psychological Bulletin*, 1967, *68*, 77-80.

Knapp, T.R. The reliability of a dichotomous test-item: A "correlationless" approach. *Journal of Educational Measurement*, 1977, *14*, 237-252.

Kuder, G.F., and Richardson, M.W. The theory of the estimation of test reliability. *Psychometrika*, 1937, *2*, 151-160.

Lord, F.M., and Novick, M.R. *Statistical Theories of Mental Test Scores*. Reading, Mass.: Addison-Wesley, 1968.

Shoemaker, D.M. Toward a framework for achievement testing. *Review of Educational Research*, 1975, *45*, 127-147.

Swinton, Spencer S. On the reliability of item clusters. Paper presented at NCME, April 1979.

Werts, C.E., Linn, R.L., and Jöreskog, K. A congeneric model for Platonic true scores. Educational and Psychological Measurement, 1973, 33, 311-318.

Wilcox, R.R. New methods for studying stability and equivalence. In C.W. Harris, A.P. Pearlman, and R.R. Wilcox, Achievement Test Items--Methods of Study. CSE Monograph Series in Evaluation, No. 6. Los Angeles: Center for the Study of Evaluation, University of California, 1977, Chapters 4, 5.

Wilcox, R.R., and Harris, C.W. On Emrick's "An evaluation model for mastery testing." Journal of Educational Measurement, 1977, 14, 215-218.

SECTION II

Contents

Page

An Algebraic Estimation Procedure 2

A Least-Square Method: MINRES 5

The Maximum Likelihood Method 15

The Newton-Raphson Method and the Method of Scoring . . 21

The Goodman Method 22

The Monte Carlo Study 30

Results 36

Convergence of the Iterative Procedures 37

Sum of Squared Residuals for the Minres Procedure . . . 45

Estimates of k 45

Estimates of x_t 68

Summary and Conclusions 80

References for Section II 89

Appendix I: The First and Second Partial Derivatives of the Log Likelihood Function for the Newton-Raphson Method 91

Appendix II: FORTRAN Program Used to Generate the Response Data and to Estimate the Parameters of the Primitive Model 95

Appendix III: Summaries of the Monte Carlo Study by Combinations of the Parameters k and x_t's, Sample Size (n) and Number of Items (m) 112

SECTION II

Consider a population of examinees at a given stage of instruction. Assuming that the primitive model holds for such a population of examinees and for a domain of items, we are interested in characterizing the domain of items in terms of the population parameters k and the various x_t's. We shall develop procedures to estimate k and various values of x_t from matched data for m different items drawn randomly from the same domain. Note that k and the various values of x_t are parameters describing the domain and each item in the domain.

For a particular item t drawn from the item domain, the primitive model explains the observable behavior of a group of examinees in terms of an undefined latent trait. It assumes that the latent trait is dichotomous with categories designated by (+) and (-). Thus, for examinees belonging to the (+) category, the probability of observing the positive (or the correct) response is $(1 - x_t)$, and the probability of observing the negative (or incorrect) response is x_t. In contrast, for examinees belonging to the (-) category, the probabilities are 0 (i.e., no guessing), and 1, respectively. Note that the responses to the item depend only on the latent trait categories, and not on any other known characteristic of the examinees, nor on any other variables available to us.

If the items are selected independently, i.e., not linked, it follows that once the latent category to which the examinees belong is determined, the probability of observing a particular response on item t is not altered by the knowledge of the actual performance on another item, say t'. That is, within each latent category the responses on these two items are stochastically independent. Conditional on the latent category, the joint probability of observing particular responses to item t and t' is the product of the probabilities of observing the particular responses on each item separately. For example, for examinees belonging to the (+) latent category, the probability of observing positive responses on both items is $(1 - x_t)(1 - x_{t'})$. This is known as local independence (Anderson, 1959, Lazarsfeld, 1959, Lazarsfeld and Henry, 1968, Lord and Novick, 1968). Within each latent category, responses to different items are mutually and stochastically independent. Anderson describes it as follows: "The proposition is that the latent quantities are the only important factors and that once these are determined behavior is random (in the sense of statistical independence). In another terminology, the set of individuals with specified latent characteristics are 'homogeneous'" (p. 11). Once we have determined that the examinees belong to a particular latent category, all systematic variation in the observed responses should disappear, leaving only pure random variation. Note that the assumption of local independence does not imply that the observed responses to items are unrelated over the whole population of examinees.

As Lord and Novick (1968, p. 361) explain, the assumption of local independence is equivalent to the statement that the latent trait completely specifies the observed responses on an item. Suppose local independence does not hold. For a group of examinees belonging to the (+) category, let us assume that the probability of observing positive responses to both items t and t' is different from $(1 - x_t)(1 - x_{t'})$. If this is not a unique occurrence, this would mean that for different groups of examinees belonging to the (+) category, the probability is systematically different from one group to another. But this is contrary to our assumption that the latent trait is dichotomous, and completely accounts for any systematic variation among the groups. This is the concept of a "complete latent space" introduced by Lord and Novick (p. 359). The assumption of local independence is thus equivalent to our assumption of the existence of an undefined dichotomous latent trait.

An algebraic estimation procedure. One method of estimation is to obtain an algebraic solution for κ and the x_t's in terms of the first- and second-order moments of the item responses. When we have observations for only a sample of examinees, this is only an approximate method of estimation and quite possibly can be improved. Suppose we administer the m items randomly drawn from the same domain to the population of examinees. Denote N as the size of population of examinees. Let

$$u_{\alpha t} = \begin{vmatrix} 1, & \text{if examinee i responds correctly to item t} \\ 0, & \text{otherwise.} \end{vmatrix}$$

Denote $U_{\cdot t}$ as the random variable that takes on values $u_{\alpha t}$ over the population of examinees. Then the expected value of $U_{\cdot t}$ or the expected response on item t over the population of examinees is

$$\begin{aligned} E(U_{\cdot t}) &= \frac{1}{N} \sum_{\alpha=1}^{N} u_{\alpha t} \\ &= 1 \times Pr(U_{\cdot t} = 1) + 0 \times Pr(U_{\cdot t} = 0) \\ &= Pr(U_{\cdot t} = 1). \end{aligned}$$

From the primitive model, this is equal to

$$E(U_{\cdot t}) = Pr(U_{\cdot t} = 1) = k(1 - x_t).$$

Now consider the joint responses to any two such items. With local independence, this can be summarized in a 2 × 2 table in terms of the parameters k, x_1 and x_2. See Figure 3 in Section I. The entries in the 2 × 2 table represent the probabilities of observing the joint responses on the two items. These represent the proportions of examinees in the population giving the particular combinations of responses to items 1 and 2. For example, the upper left cell of the table represents the proportion of examinees in the population giving the correct responses to both items:

$$\Pr(U_{\cdot 1} = 1,\ U_{\cdot 2} = 1) = k(1 - x_1)(1 - x_2),$$

similarly for the others. Note that these quantities are in terms of the parameters k, x_1 for item 1 and x_2 for item 2.

The joint second-order moment over the population of examinees is

$$\begin{aligned}
E(U_{\cdot 1}U_{\cdot 2}) &= \frac{1}{N}\sum_{\alpha=1}^{N} u_{\alpha 1}u_{\alpha 2} \\
&= 1 \times 1 \times \Pr(U_{\cdot 1}=1,\ U_{\cdot 2}=1) + 1 \times 0 \times \Pr(U_{\cdot 1}=1,\ U_{\cdot 2}=0) + \\
&\quad 0 \times 1 \times \Pr(U_{\cdot 1}=0,\ U_{\cdot 2}=1) + 0 \times 0 \times \Pr(U_{\cdot 1}=0,\ U_{\cdot 2}=0) \\
&= \Pr(U_{\cdot 1}=1,\ U_{\cdot 2}=1) \\
&= k(1 - x_1)(1 - x_2).
\end{aligned}$$

Now denote

$$E(U_{\cdot i}) = k(1 - x_i) = P_i$$

and

$$E(U_{\cdot i}U_{\cdot j}) = k(1 - x_i)(1 - x_j) = P_{ij},\quad i \neq j.$$

These are called accounting equations by Lazarsfeld and Henry (1968). Treating the response to each item as a random variable, the accounting equations relate the first- and second-order moments to the parameters k and the various values of x_i. The next step then is to solve for the parameters in terms of these moments. For m items, we have m equations relating to the first moments and m(m-1)/2 equations relating to the second-order (or joint) moments. If the model holds for this population of examinees, we have m + m(m-1)/2 or m(m+1)/2 equations in m + 1 unknowns.

One approach to this problem was originally developed by Lazarsfeld. This was proposed in connection with the Latent Structure Model with polynomial trace line (Lazarsfeld, 1950). The first moments of individual items and second-order moments of all pairs of two items are set down in the form of a matrix. In the first row and first column of this matrix (called Σ when presented below) are the first moment for each item, and the rest of the elements in this matrix are the joint moments of all pairs of two items. At present we shall leave the diagonal elements undefined. Such a matrix Σ can be constructed from the response data. We note that the off-diagonal elements of Σ can be reproduced by the product of a vector A and its transpose, where the elements of A are

$$k^{1/2},\ k^{1/2}(1 - x_1),\ k^{1/2}(1 - x_2),\ \ldots,\ k^{1/2}(1 - x_m).$$

The reproduced diagonal will be $k, k(1-x_1)^2, k(1-x_2)^2, \ldots, k(1-x_m)^2$. Thus if we substitute this diagonal of AA' for the diagonal of Σ, i.e., $\Sigma' = \Sigma - \text{diag}\ \Sigma + \text{diag}\ AA'$, the resulting matrix Σ' will be rank one and can be reproduced exactly by the product of A and its transpose. For any rank one matrix the determinant of any second-order minor will be zero. Spearman used this relationship and proposed a way to estimate the factor loadings from a sample correlation matrix. We apply the same method to estimate the parameters from a sample proportion matrix.

In order to derive the Spearman solution, denote

$$P_{0i} = P_i, \quad i = 1, 2, \ldots, m,$$

$$P_{ij} = P_{ij}, \quad i, j = 1, 2, \ldots, m,\ i \neq j,$$

and

$$A = ||a_0, a_1, \ldots, a_m||',$$

where

$$a_0 = k^{1/2}$$

$$a_i = k^{1/2}(1 - x_i), \quad i = 1, 2, \ldots, m.$$

Substitute the diagonal of Σ with a_i^2's, and consider all the second-order minors involving exactly one term in a_i^2. They are

$$A_{ij\ell} = \left|\left|\begin{matrix} a_i^2 & P_{i\ell} \\ P_{ji} & P_{j\ell} \end{matrix}\right|\right|, \quad j \neq \ell \neq i, \quad j, \ell = 0, 1, \ldots, m.$$

Since Σ' is rank one, the determinants of all these minors will vanish. Thus,

$$a_i^2 P_{j\ell} - P_{ji}P_{i\ell} = 0, \quad j \neq \ell \neq i, \quad j, \ell = 0, 1, \ldots, m.$$

Solving for a_i^2, we have

$$a_i^2 = \frac{P_{ji}P_{i\ell}}{P_{j\ell}}, \quad j \neq \ell \neq i, \quad j, \ell = 0, 1, \ldots, m.$$

But for fixed i, there are m(m-1) different minors that satisfy this condition. The Spearman solution is simply to take the ratio of the average of the numerators and the average of the denominators for all the m(m-1) determinantal equations involving a_i^2. That is,

$$a_i^2 \simeq \frac{\frac{1}{m(m-1)} \sum_{j \neq i}^{m} \sum_{\ell \neq i,j}^{m} P_{ji} P_{i\ell}}{\frac{1}{m(m-1)} \sum_{j \neq i}^{m} \sum_{\ell \neq i,j}^{m} P_{j\ell}}$$

for i = 0, 1, 2, ..., m. To estimate k and x_i's from a sample of n examinees, we substitute the sample moments for P_i's and P_{ij}'s, and solve for the a_i^2's. Denote $\hat{a}_i^2$ as the estimate of a_i^2. Then

$$\hat{k} = \hat{a}_0^2,$$

$$\hat{x}_i = 1 - \frac{\sqrt{\hat{a}_i^2}}{a_0^2}, \quad i = 1, 2, \ldots, m.$$

In any particular instance one can then use these estimates to reproduce the off-diagonal elements of Σ and compare them with the observed values.

A least-square method: MINRES. The Spearman procedure gives values that fit either well or poorly only the off-diagonal elements of Σ. One criterion that we might use is to minimize the sum of squared deviations between the off-diagonal elements of Σ and of the reproduced $\hat{A}\hat{A}'$. This may be formulated as finding the estimate $\hat{A}$ such that

$$N(\hat{A}) = \mathrm{tr}(\Sigma^* - \hat{A}\hat{A}' + \mathrm{diag}\, \hat{A}\hat{A}')^2$$

$$= \sum_{i=0}^{m} \sum_{j \neq i}^{m} (p_{ij} - \hat{a}_i \hat{a}_j)^2,$$

where $\Sigma^* = \Sigma - \mathrm{diag}\, \Sigma$, is at a minimum. After the estimate $\hat{A}$ is determined, we apply the same formulas as in the Spearman's procedure to solve for estimates of k and the various x_t's.

Fitting the off-diagonal elements with a matrix of lower rank is not a new procedure. Several authors have tackled this same problem in the context of Factor Analysis (see Comrey, 1962; Comrey and Ahumada, 1965; Harman and Jones, 1966; Harman and Fukada, 1966; Thurstone, 1955). The difficulty arises because no simple closed-form solution is available and the minimum of the function can only be obtained numerically. One such solution developed and tested by Harman and Jones (1966) is the Minres (Minimum Residual) method. See examples in Harman (1967) and Mulaik (1972).

It should be noted that the present problem is different from minimizing trace $(\Sigma - \hat{A}\hat{A}')'(\Sigma - \hat{A}\hat{A}')$, or trace $(\Sigma - D - \hat{A}\hat{A}')'(\Sigma - D - \hat{A}\hat{A}')$. These would lead to a principal or modified component solution for $\hat{A}$ (Anderson, 1959). In these cases, the diagonal elements are also reproduced and included in the least-square criterion.

A necessary condition for a maximum or minimum of the objective function N(A) at $A = \hat{A}$ is that the first partial derivatives of N(A) with respect to the elements of the column vector $\hat{A}$ are zeros. That is,

$$\frac{\partial N(A)}{\partial A} = \left|\left|\frac{\partial N(A)}{\partial_{ai}}\right|\right| = ||0||, \text{ at } A = \hat{A}.$$

Such a value of the function is called a stationary (Morrison, 1971) or local maximum or minimum, as opposed to a global extremum which might exist on the boundary of the admissible region of A, or as a cusp or other form at which the derivatives were undefined. A sufficient condition for a maximum at point A satisfying the necessary condition is that the matrix of second partial derivatives (called the Hessian matrix) evaluated at A is negative definite. Similarly, a positive definite Hessian is a sufficient condition for a local minimum. If the Hessian is semidefinite, the test fails. The higher-order terms in the Taylor expansion of N(A) must be examined in the vicinity of the stationary point $\hat{A}$ to determine whether we have a local maximum or minimum. If the Hessian is an indefinite matrix at $\hat{A}$, then N(A) is neither a maximum or minimum at the point $\hat{A}$.

To find an $\hat{A}$ that would minimize the objective function N(A), we set the first partial derivative of N(A) with respect to A to zero and solve for A. We may apply the formulas for taking the derivatives of traces described in Mulaik (1972, p. 153). Hence,

$$\frac{\partial N(A)}{\partial A} = \frac{\partial}{\partial A}\, \text{tr}(\Sigma^* - AA' + \text{diag } AA')^2$$

$$= -4\Sigma^*AA' + 4AA'A - 4(\text{diag } AA')A.$$

Setting this equation to zero, dividing both sides by 4, and rearranging terms, we obtain the equation

$$\Sigma^*A = (AA' - \text{diag } AA')A.$$

These are m+1 nonlinear simultaneous equations in a_i's and cannot be solved algebraically.

There are many algorithms available to find the solutions to these equations, such as the gradients method, the Gauss-Seidel method, the Newton-Raphson method, or the Fletcher-Powell method. In their search for an efficient algorithm, Harman and Jones (1966) compared and discarded several variants of the gradient methods and a technique of repeated calculations of a principal component A and diag AA' leading to improvements in minimizing N(A). Instead, they found the Gauss-Seidel method or the method of successive displacement to be more efficient. The gradient methods seek an optimal value (maximum or minimum) of a function, iteratively, by proceeding from a trial solution to the next approximation in the direction of maximal change in the function whereas the method of successive displacements is an iterative process in which small changes are made in the variable and the corresponding new variables replace the original ones. In particular, when applying this method to our problem, it is evident that, if changes or displacements are introduced in only one element of A, the reproduced proportion will be linear functions of these displacements, and the objective function N(A) will be quadratic only, as opposed to a fourth-degree polynomial required in the gradient methods. Moreover, this method does not require one to calculate the inverse of the matrix of the partial derivatives of N(A) with respect to A as in the Newton-Raphson Method. It is also conceptually simpler than the Fletcher-Powell Method. For discussion on the latter two methods, see Mulaik (1972, pp. 154-160).

Consider the equation

$$\Sigma^* A = (AA' - \text{diag } AA')A.$$

This is the necessary condition for N(A) to have a minimum at $A = \hat{A}$. If we multiply the matrices on both sides of the equation, we have

$$\left| \begin{array}{c} \sum_{j \neq 0}^{m} p_{0j} a_j \\ \vdots \\ \sum_{j \neq i}^{m} p_{ij} a_j \\ \vdots \\ \sum_{j \neq m}^{m} p_{mj} a_j \end{array} \right| = \left| \begin{array}{c} a_0 \sum_{j \neq 0}^{m} a_j^2 \\ \vdots \\ a_i \sum_{j \neq i}^{m} a_j^2 \\ \vdots \\ a_m \sum_{j \neq m}^{m} a_j^2 \end{array} \right| .$$

Thus for any fixed i, we may write

$$\sum_{j \neq i}^{m} p_{ij} a_j = a_i \sum_{j \neq i}^{m} a_j^2 .$$

Solving for a_i, we have

$$a_i = \frac{\sum_{j\neq i}^{m} p_{ij}a_j}{\sum_{j\neq i}^{m} a_j^2}$$

for $i = 0, 1, 2, \ldots, m$. Note that a_i does not appear on the right-hand side of the equation. Starting with an initial approximation, say $a_i^{(0)}$'s, this suggests that we may calculate a_i's repeatedly using this relationship. That is, let the superscript q denote the q-th trial of iterations. For the q-th trial, we calculate $a_i^{(q+1)}$ using the $a_i^{(q)}$'s of the previous trial:

$$a_i^{(q+1)} = \frac{\sum_{j\neq i}^{m} p_{ij}a_j^{(q)}}{\sum_{j\neq i}^{m} (a_j^{(q)})^2}$$

for $i = 0, 1, 2, \ldots, m$, $q = 0, 1, 2, \ldots$, and with $a_i^{(q)} = a_j^{(q+1)}$, if $j < i$. We repeat this process until the differences between two successive trial values of all the $a_i^{(q)}$'s are negligible.

To see that this procedure will lead to a minimum of N(A) and is equivalent to the Gauss-Seidel process, we need to approach the problem from a different regard. Denote $A^{(0)} = [a_i^{(0)}]$ as some initial approximation to A. We can calculate the objective function N(A) at $A = A^{(0)}$, i.e.,

$$N(A^{(0)}) = \sum_{j=0}^{m} \sum_{\ell\neq j}^{m} (p_{j\ell} - a_j^{(0)}a_\ell^{(0)})^2.$$

Suppose for the i-th element of $A^{(0)}$, $a_i^{(0)}$, an increment e is added. Substituting $a_i^{(0)} + e$ for $a_i^{(0)}$, we have

$$\begin{aligned} N'(A^{(0)}) &= \sum_{\substack{j=0\\ j\neq i}}^{m} \sum_{\ell\neq j}^{m} (p_{j\ell} - a_j^{(0)}a_\ell^{(0)})^2 + \sum_{\ell\neq i}^{m} (p_{i\ell} - a_i^{(0)}a_\ell^{(0)})^2 \\ &= N(A^{(0)}) + e^2 \sum_{\ell\neq i}^{m} (a_\ell^{(0)})^2 - 2e \sum_{\ell\neq i}^{m} (p_{i\ell} - a_i^{(0)}a_\ell^{(0)})a_\ell^{(0)}. \end{aligned}$$

Thus, the changes in the objective function N(A) induced by changing one of the a_i's is

$$\Delta_i(e,A^{(0)}) = N(A^{(0)}) - N'(A^{(0)})$$

$$= -e^2 \sum_{\ell \neq i}^{m} (a_\ell^{(0)})^2 + 2e \sum_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(0)} a_\ell^{(0)}) a_\ell^{(0)}.$$

This is a function of e and the approximation $a_i^{(0)}$'s.

The subscript i for $\Delta_i(e,A^{(0)})$, denoting the increment, is added to $a_i^{(0)}$. Given $A^{(0)}$, then, we want to find the e that will maximize the changes in the decrement of the objective function. To find e, we set the partial derivative of $\Delta_i(e,A^{(0)})$ with respect to e to zero and solve for e. Thus,

$$\frac{\partial \Delta_i(e,A^{(0)})}{\partial e} = -2e \sum_{\ell \neq i}^{m} (a_\ell^{(0)})^2 + 2 \sum_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(0)} a_\ell^{(0)}) a_\ell^{(0)}.$$

Setting this to zero, dividing by 2 and solving for e, we have

$$e = \frac{\sum_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(0)} a_\ell^{(0)}) a_\ell^{(0)}}{\sum_{\ell \neq i}^{m} (a_\ell^{(0)})^2}.$$

Note that the second partial derivative of $\Delta_i(e,A^{(0)})$ with respect to e is

$$\frac{\partial^2 \Delta_i(e,A^{(0)})}{\partial e^2} = -2 \sum_{\ell \neq i}^{m} (a_\ell^{(0)})^2 < 0,$$

for some $a_\ell^{(0)} = 0$. This implies the above choice of e will maximize $\Delta_i(e,A^{(0)})$. Now if we repeat this for i = 0, 1, ..., m, we would have a sequence of non-increasing values of the objective function,

$$N(A^{(0)}) \geq N(A_0^{(0)}) \geq \ldots \geq N(A_1^{(0)}) \geq \ldots \geq N(A_i^{(0)}) \geq \ldots .$$

The $N(A_i^{(0)})$ indicates that the objective function is evaluated at

$$a_0^{(0)} + e_0, \ \ldots, \ a_i^{(0)} + e_i, \ a_{i+1}, \ \ldots, \ a_m.$$

The equality holds when $p_{i\ell} = a_i^{(0)} a_\ell^{(0)}$. This means that the objective function will be zero. Otherwise, this represents one cycle of the iteration process and we may repeat this sequence of operations again. To avoid confusion, it is convenient to indicate $e_i^{(1)}$ as the first increment for $a_i^{(0)}$ and denote $a_i^{(1)} = a_i^{(0)} + e_i^{(1)}$ as the resulting new adjusted approximation for the final solution $\hat{a}_i$. Hence, beginning with $a_i^{(1)}$, we repeat this cycle and obtain another sequence of non-increasing values of the objective function,

$$\ldots \geq N(A_m^{(0)}) \geq \ldots \geq N(A_i^{(1)}) \geq \ldots \geq N(A_m^{(1)}) \geq \ldots .$$

After we repeat this cycle a number of times, and the objective function stabilizes, we may reach the local minimum of the function. That is, if the difference between $N(A_m^{(q)} - N(A_m^{(q-1)})$ is negligible, we may say that we have reached a local minimum. But since $N(A)$ is a quadratic function and is always positive, this local minimum is also the global minimum.

Note that at any given point of the iterations,

$$N(A_{i-1}^{(q)} - N(A_i^{(q)}) = -(e_i^{(q)})^2 \sum_{\ell \neq i}^{m} (a_\ell^{(q)})^2$$

$$+ 2(e_i^{(q)}) \sum_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(q)} a_\ell^{(q)}) a_\ell^{(q)}$$

where

$$a_\ell^{(q)} = a_\ell^{(q-1)} + e_\ell^{(q)} \quad \text{if} \quad \ell < i,$$

and

$$a_i^{(q)} = a_\ell^{(q-1)} \quad \text{if} \quad \ell > i.$$

If we substitute

$$e_i^{(q)} = \frac{\sum_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(q)} a_\ell^{(q)}) a_\ell^{(q)}}{\sum_{\ell \neq i}^{m} (a_\ell^{(q)})^2}$$

for $e_i^{(q)}$, we have

$$N(A_{i-1}^{(q)}) - N(A_i^{(q)}) = \frac{\left| \sum_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(q)} a_\ell^{(q)}) a_\ell^{(q)} \right|^2}{\sum_{\ell \neq i}^{m} (a_\ell^{(q)})^2} \geq 0.$$

This is always non-negative if some of the $a_\ell^{(q)}$'s are not zero. If none of the $a_\ell^{(q)}$'s is zero, and this is relatively small, it means that we have found a relatively good fit for the off-diagonal elements of the i-th row (or the ℓ-th column) of Σ. Now if this also holds for $N(A_m^{(q)}) - N(A_m^{(q+1)})$, adding new increments to a_j's will probably not change the objective function. Since the $a_i^{(q+1)}$ is a function of the other $a_i^{(q+1)}$'s, this means that the $a_i^{(q+1)}$'s have reached stability. Thus, we may use the criterion

$$\max_{i=0,1,\ldots,m} \left| a_i^{(q)} - a_i^{(q+1)} \right| \leq \underline{d}.$$

as a stopping criterion. Furthermore,

$$\begin{aligned} a_i^{(q+1)} &= a_i^{(q)} + e_i^{(q+1)} \\ &= a_i^{(q)} + \frac{\sum\limits_{\ell \neq i}^{m} (p_{i\ell} - a_i^{(q)} a_\ell^{(q)}) a_\ell^{(q)}}{\sum\limits_{\ell \neq i}^{m} (a_\ell^{(q)})^2} \\ &= \frac{\sum\limits_{\ell \neq i}^{m} p_{i\ell} a_\ell^{(q)}}{\sum\limits_{\ell \neq i}^{m} (a_\ell^{(q)})^2} \end{aligned}$$

for $i = 0, 1, 2, \ldots, m$, $q = 0, 1, 2, \ldots$, and with $a_\ell^{(q)} = a_\ell^{(q+1)}$, if $\ell < i$. This is the same as we have derived heuristically previously.

The Gauss-Seidel Process was originally developed for systems of linear equations. It is conceptually simple and easy to implement. However, the iterative process may not converge and the estimates a_i's may not be bounded by zero and one. In general, a sufficient condition for the Gauss-Seidel Process to converge is for $\Sigma^* = \Sigma - \text{diag}\, \Sigma$ to be positive definite. But Σ^* has zeros in the diagonal, hence it can at best be positive semi-definite. Thus it is possible that the procedure outlined above may not converge. Moreover, the final solution for the estimates may fall outside the interval (0,1). This is not admissible because the a_i's are bounded by the $p_{i\ell}$'s which in turn are bounded by zero and one.

Harman and Fukada (1966) dealt with this problem in connection with the well-known Heywood case in Factor Analysis. The Heywood case arises when the estimated communality is greater than one, i.e., $a_i^2 > 1$ for some i. They showed that to find the minimum of $N(A_i^{(q)})$ is effectively a process of locating a point having minimum distance from a fixed point. If this point lies inside the region $0 < a_i^2 < 1$ then this point is the minimizing point. On the other hand, if the given point is outside of the region, i.e., $a_i^2 > 1$, then a point belonging to the region must lie on the boundary in order to be at a minimum distance from the fixed point. Suppose for $N(A_i^{(q)})$

$$b = a_i^{(q-1)} + e_i^{(q)}$$

denotes the point that will minimize $N(A_i^{(q)})$. Then we can write, substituting b for $a_i^{(q)}$,

$$\begin{aligned}
N(A_i^{(q)}) &= \sum_{\substack{j=0 \\ j \neq i}}^{m} \sum_{\ell \neq j}^{m} (p_{i\ell} - a_j^{(q)} a_\ell^{(q)})^2 \\
&\quad + \sum_{\ell \neq i}^{m} (p_{i\ell} - b a_\ell^{(q)})^2 \\
&= \sum_{\substack{j=0 \\ j \neq i}}^{m} \sum_{\ell \neq j}^{m} (p_{j\ell} - a_j^{(q)} a_\ell^{(q)})^2 \\
&\quad + \sum_{\ell \neq i}^{m} p_{i\ell}^2 - 2b \sum_{\ell \neq i}^{m} a_\ell^{(q)} p_{i\ell} + b^2 \sum_{\ell \neq i}^{m} (a_\ell^{(q)})^2 .
\end{aligned}$$

Next denote

$$c_1 = \sum_{\ell \neq i}^{m} (a_\ell^{(q)})^2 ,$$

$$c_2 = \sum_{\ell \neq i}^{m} a_\ell^{(q)} p_{i\ell} ,$$

$$c_3 = \sum_{\substack{j=0 \\ j \neq i}}^{m} \sum_{\ell \neq j}^{m} (p_{i\ell} - a_i^{(q)} a_\ell^{(q)})^2 + \sum_{\ell \neq i}^{m} p_{i\ell}^2 .$$

Then $N(A_i^{(q)})$ becomes a quadratic function in b, with coefficients c_1, c_2, and c_3, i.e.,

$$N(A_i^{(q)}) = c_1 b^2 - 2c_2 b + c_3.$$

Note that c_1, c_2, and c_3 are functions of $a_i^{(q)}$'s and $p_{i\ell}$'s; these are known values. Then, completing the square, we have

$$N(A_i^{(q)}) = c_1 \left| b - \frac{c_2}{c_1} \right|^2 + \left| c_3 - \frac{c_2^2}{c_1} \right|.$$

Now if b lies within the region $0 < b^2 < 1$, then

$$b = \frac{c_2}{c_1} = \frac{\sum_{\ell \neq i}^{m} a_\ell^{(q)} p_{i\ell}}{\sum_{\ell \neq i}^{m} (a_\ell^{(q)})^2}$$

will be the minimizing point. This is the same as what we have previously obtained. On the other hand, if b is outside of the region, say $b > 1$, then the point $b = 1$ must also be a minimum under the constraints $0 < b < 1$. To see this, suppose

$$b = 1 + \varepsilon, \quad \text{with} \quad \varepsilon > 0.$$

Substituting $1 + \varepsilon$ for b, we have

$$N(A_i^{(q)}) = c_1 \left| 1 + \varepsilon - \frac{c_2}{c_1} \right|^2 + \left| c_3 - \frac{c_2^2}{c_1} \right|.$$

For $N(A_i^{(q)})$ to be a minimum at $1 + \varepsilon$, the partial derivative of $N(A_i^{(q)})$ with respect to ε must be zero, i.e., the slope of the tangent line is

$$M = \frac{\partial(N(A_i^{(q)})}{\partial e} = 2c_1 \left| 1 + \varepsilon - \frac{c_2}{c_1} \right| = 0.$$

Solving for ε, we have

$$\varepsilon = \frac{c_2}{c_1} - 1.$$

Since

$$c_1 = \sum_{\ell=i}^{m} (a_\ell^{(q)})^2 > 0$$

and ε is assumed to be greater than zero, then

$$\frac{c_2}{c_1} > 1.$$

Consequently,

$$M < 0 \text{ if } 0 < \varepsilon < \frac{c_2}{c_1} - 1$$

$$M = 0 \text{ if } \varepsilon = \frac{c_2}{c_1} - 1$$

$$M > 0 \text{ if } \varepsilon > \frac{c_2}{c_1} - 1.$$

Now if $\varepsilon = 0$ (or $b = 1$), the function $N(A_i^{(q)})$ is decreasing since $M < 0$. In fact, the objective function $N(A_i^{(q)})$ is a decreasing function with respect to ε. Thus under the constraint $b < 1$, the minimum of the objective function will be at $b = 1$, if $\varepsilon > 0$. A similar argument also applies to the case where $b < 0$.

With this information, we may try to minimize the objective function $N(A_i^{(q)})$ with the constraint $b < 1$ by using the Lagrange multiplier. But this will lead to the solution that $b = 1$ unconditionally. This is of little utility. Consequently, we propose to follow the procedure for the unrestricted case and set a_i's to a value close to zero or one if at any given trial of iterations the obtained solution is outside of the acceptable region, i.e., less than zero or greater than one, respectively. This follows from the rationale that if the objective function is at a minimum for $a_i^{(q)}$ outside of the region, the objective function for the point $a_i^{(q)} = 1$ or $a_i^{(q)} = 0$ lying on the boundaries must be a minimum under the constraint on $a_i^{(q)}$. This will guarantee that the final solutions of a_i's will be within the acceptable region. The effect that this procedure will have on the convergence to the minimum value of the objective function, however, is not clear. Finally, it is proposed to use the algebraic solution as the initial estimate $A^{(0)}$.

The maximum likelihood method. Perhaps the most widely used method of estimating parameters for the Latent Class Model is the method of Maximum Likelihood. The principle of maximum likelihood assumes that the sample is representative of the population and chooses as the estimates those values of the parameters which maximize the distribution function. Given a sample of response patterns, the sampling distribution is considered as a function of the parameters k, $x_1, \ldots, x_m$, and is called the likelihood function of these parameters. Thus to find the maximum likelihood estimators (MLE) for the parameters we need first to define the sampling distribution of a sample of response patterns. To do this, we shall first consider a response model for m items.

Given local independence, we can define the joint probabilities of responses to m items drawn randomly from the same item domain. For m items, each with two possible responses, i.e., positive or correct and negative or incorrect, there are 2^m possible patterns of responses. It is assumed that k is fixed and the x_t's are different for the m items, $t = 1, \ldots, m$. We can derive the probability of observing any particular response pattern from the primitive model over the population of examinees.

Let a response pattern w_α be

$$w_\alpha = (u_{\alpha 1}, u_{\alpha 2}, \ldots, u_{\alpha t}, \ldots, u_{\alpha m})$$

where

$$u_{\alpha t} = 1, \quad \text{if the response is positive or correct on item } t,$$

or

$$= 0, \quad \text{if the response is negative or incorrect on item } t.$$

Thus, w_α is an m-tuple expressible as a string of zeros and ones of of length m. We will denote by S the set of all 2^m such strings.

Assuming a dichotomous latent class which has categories designated by (+) and (-), we can partition the population of examinees into two mutually exclusive groups according to their latent category designations. Denote k, as we have done previously, as the proportion of examinees belonging to the (+) category in the population. That is,

$$Pr(+) = k = \text{Proportion of examinees belonging to the (+) category.}$$

We can also denote the proportion of examinees belonging to the (-) category by

$$\begin{aligned} Pr(-) &= 1 - Pr(+) \\ &= 1 - k = \text{Proportion of examinees belonging to the (-) category,} \end{aligned}$$

since the partitioning of the examinees in the population is exhaustive and mutually exclusive. We can then write the probability of observing any response pattern w_α as

$$Pr(w_\alpha) = Pr(+)Pr(w_\alpha \mid +) + Pr(-)Pr(w_\alpha \mid -)$$

where $Pr(w_\alpha \mid +)$ = conditional probability of observing the response pattern w_α given that the examinees belonging to the (+) category, and,

$Pr(w_\alpha \mid -)$ = conditional probability of observing the response pattern w_α given that the examinees belonging to the (-) category.

Local independence implies that within each latent category the responses to the different items are mutually and stochastically independent. Hence for examinees in the (+) category, we can write the probability of observing the pattern w_α as the product of the separate probabilities of the particular responses on each of the m items. That is,

$$\begin{aligned} Pr(w_\alpha \mid +) &= Pr(u_{\alpha 1} \mid +)Pr(u_{\alpha 2} \mid +) \ldots Pr(u_{\alpha m} \mid +) \\ &= \prod_{t=1}^{m} Pr(u_{\alpha t} \mid +) \end{aligned}$$

and

$$\begin{aligned} Pr(w_\alpha \mid -) &= Pr(u_{\alpha 1} \mid -)Pr(u_{\alpha 2} \mid -) \ldots Pr(u_{\alpha m} \mid -) \\ &= \prod_{t=1}^{m} Pr(u_{\alpha t} \mid -). \end{aligned}$$

For any item t, the primitive model further assumes that for examinees in the (+) category, the probability of a positive response is

$$\Pr(u_{\alpha t} = 1 \mid +) = 1 - x_t$$

and the probability of a negative or incorrect response is

$$\Pr(u_{\alpha t} = 0 \mid +) = x_t.$$

We can combine these two equations into one by using the following notation:

$$\Pr(u_{\alpha t} \mid +) + (1 - x_t)^{u_{\alpha t}} x_t^{1-u_{\alpha t}}.$$

Therefore for examinees in the (+) category, the probability of observing a particular response pattern w_α is

$$\Pr(w_\alpha \mid +) = \prod_{t=1}^{m} (1-x_t)^{u_{\alpha t}} x_t^{1-u_{\alpha t}}.$$

For the examinees in the (-) category, the conditional probability of positive or correct response is zero for any item drawn randomly from the same item domain, while the conditional probability of a negative or incorrect response is unity. That is,

$$\Pr(u_{\alpha t} = 1 \mid -) = 0$$

and

$$\Pr(u_{\alpha t} = 0 \mid -) = 1.$$

Denote $w_0 = (0, 0, \ldots, 0)$. Then

$$\Pr(w_\alpha \mid -) = \left| \begin{array}{ll} 1, & \text{for } w_\alpha = w_0 \\ 0, & \text{for } w_\alpha \neq w_0. \end{array} \right.$$

Now the unconditional probability of observing any response pattern w_α can be represented as

$$\Pr(w_\alpha) = \Pr(+)\Pr(w_\alpha \mid +) + \Pr(-)\Pr(w_\alpha \mid -)$$

$$= \begin{cases} k \prod_{t=1}^{m} (1-x_t)^{u_{\alpha t}} x_t^{1-u_{\alpha t}}, & w_\alpha \neq w_0, \\ k \prod_{t=1}^{m} x_t + 1 - k, & w_\alpha = w_0. \end{cases}$$

For a sample of n examinees, denote $f(w_\alpha)$ = frequency of the response pattern w_α. The occurrences of these 2^m possible response patterns are mutually distinct events. That is, at a given administration of the m items, an examinee cannot simultaneously produce two different patterns of responses to the m items. Then the event of observing the response pattern w_α from n independent examinees occurs exactly $f(w_\alpha)$ times with probability $\Pr(w_\alpha)$, for all 2^m possible response patterns. Clearly, $\Sigma f(w_\alpha) = n$, and $\Sigma \Pr(w_\alpha) = 1$. Hence, the probability distribution function of observing $f(w_\alpha)$'s, the frequencies of response patterns w_α's, in a sample of n examinees is a multinomial distribution each with probability $\Pr(w_\alpha)$ (Rao, 1973, p. 355):

$$\underline{L} = \underline{L}(f(w_\alpha);\ n,\ \Pr(w_\alpha))$$

$$= n! \prod \frac{\Pr(w_\alpha)^{f(w_\alpha)}}{f(w_\alpha)!}\ .$$

Since the $\Pr(w_\alpha)$'s are functions of k and x_t's, we could write $\underline{L}$ as

$$\underline{L} = \underline{L}(f(w_\alpha);\ n,\ k,\ x_1,\ x_2,\ \ldots,\ x_m)$$

$$= n! \prod \frac{\Pr(w_\alpha;\ n,\ k,\ x_1,\ x_2,\ \ldots,\ x_m)^{f(w_\alpha)}}{f(w_\alpha)!}\ .$$

The function $\underline{L}$ is the likelihood or probability of observing the combinations of different response patterns that may arise in any given administration of the m items to a sample of n examinees. $\underline{L}$ is a function of the observed frequencies $f(w_\alpha)$'s, the sample size n and the parameters k and x_t's. Our task now is to use this sampling distribution and estimate k and x_t's from the observed frequencies $f(w_\alpha)$'s.

Given the likelihood function $\underline{L}$, the maximum likelihood estimators are the values of the parameters k, x_t, ..., x_t, that maximize $\underline{L}$. This can easily be done by setting each partial derivative of $\underline{L}$ with respect to the m + ℓ parameters to zero and solving for the m + ℓ simultaneous equations. Since the logarithm of $\underline{L}$ is a monotonic increasing function of $\underline{L}$, it is convenient to work with log $\underline{L}$ rather than $\underline{L}$. Thus, the log likelihood function is

$$\underline{\ell} = \log \underline{L} = \log \left| n! \prod \frac{\Pr(w_\alpha)^{f(w_\alpha)}}{f(w_\alpha)!} \right|$$

$$= \text{const} + \sum f(w_\alpha) \log \Pr(w_\alpha)$$

$$= \text{const} + \sum_{w_\alpha \neq w_0} f(w_\alpha) \log \Pr(w_\alpha) + f(w_0) \log \Pr(w_0)$$

where

$$\text{const} = \log \left| \frac{n!}{\prod f(w_\alpha)!} \right|$$

Consider the second term of the equation. This includes all the response patterns except the one where all m responses are incorrect. From the previous section, we see that

$$\Pr(w_\alpha) = k \prod_{t=1}^{m} (1-x_t)^{u_{\alpha t}} x_t^{1-u_{\alpha t}}, \quad w_\alpha \neq w_0.$$

If we take the logarithm of $\Pr(w_\alpha)$ and multiply by $f(w_\alpha)$, we have

$$f(w_\alpha) \log \Pr(w_\alpha) = f(w_\alpha) \log k$$

$$+ f(w_\alpha) \sum_{t=1}^{m} u_{\alpha t} \log (1-x_t)$$

$$+ f(w_\alpha) \sum_{t=1}^{m} (1-u_{\alpha t}) \log x_t.$$

It can easily be shown that if we sum across all the possible response patterns $w_\alpha \neq w_0$, we have

$$\sum_{w_\alpha \neq w_0} f(w_\alpha)\Pr(w_\alpha) = (n-f_0)\log k + \sum_{t=1}^{m} f_t \log(1-x_t) + \sum_{t=1}^{m} (n-f_0-f_t)\log x_t$$

where

$$f_0 = f(w_0),$$

and

$$f_t = \sum f(w_\alpha),$$

for the set

$$S_t = \left| w_\alpha \text{ and } u_{\alpha t} = 1 \right|.$$

Since

$$\Pr(w_0) = 1 - k + k \prod_{t=1}^{m} x_t,$$

we can now write log $\underline{L}$ as

$$\underline{\ell} = \text{const} + f_0 \log(1 - k + k \prod_{t=1}^{m} x_t) + (n-f_0)\log k + \sum_{t=1}^{m} f_t \log(1-x_t)$$

$$+ \sum_{t=1}^{m} (n - f_0 - f_t)\log x_t.$$

By setting the partial derivatives of $\underline{\ell}$ with respect to k, $x_1, \ldots, x_m$ to zero, we have $m + \ell$ simultaneous nonlinear equations:

$$\frac{\partial \ell}{\partial k} = \frac{n-f_0}{k} - \frac{f_0(1 - \prod_{t'=1}^{m} x_{t'})}{1 - k + k \prod_{t'=1}^{m} x_{t'}} = 0$$

and

$$\frac{\partial \ell}{\partial x_t} = \frac{f_t}{1-x_t} + \frac{n-f_t-f_0}{x_t} + \frac{k f_0 \prod_{t'=1}^{m} x_{t'}}{(1 - k + k \prod_{t'=1}^{m} x_{t'})x_t} = 0$$

for t = 1, 2, ..., m. McHugh (1956; correction, 1958) showed that under the regularity condition a solution to these equations will lead to maximum likelihood estimators for the parameters. Although these estimators may be biased in small samples, they are consistently and asymptotically normally distributed. Derivations for these properties can be found in Rao (1973, Chapter 5) and Kendall and Stuart (1973).

The Newton-Raphson method and the method of scoring. The maximum likelihood equations as presented above are nonlinear functions. There are numerous efficient procedures available for numerically obtaining the maximum of a complicated function, particularly when a large number of variables are involved. Two of the widely used methods for multinomial models are the Newton-Raphson method and the method of scoring. Both methods are based on the Taylor Series expansion of a multivariate function and are the multivariate analog of Newton's method for solving nonlinear equations by successive linear approximations.

The Newton-Raphson method involves trial estimates and an iterative procedure that utilizes the inverse of the matrix of second partial derivatives of the log likelihood function for correcting these estimates. The difference between successive estimates is used as a measure for convergence. The method of scoring for the parameters due to Fisher differs from the Newton-Raphson method in that it uses the matrix of the expected values of the second partial derivatives, that is, the information matrix, instead of the matrix of second partial derivatives. Kale (1962) shows that under the regularity conditions, both of these iteration processes will converge in large samples.

To apply the Newton-Raphson method to our present situation, let θ be a column vector of m+1 parameters, with

$$\theta_0 = k$$

and

$$\theta_i = x_i, \quad i = 1, 2, \ldots, m.$$

Let $S(\theta)$ be an $(m+\ell) \times 1$ column matrix with

$$S(\theta) = [s_i] = \left|\frac{\partial \log L}{\partial \theta_i}\right|$$

and $M(\theta)$ be an $(m+\ell) \times (m+\ell)$ matrix with

$$M(\theta) = [m_{ij}] = \left|\frac{\partial^2 \log L}{\partial \theta_i \partial \theta_j}\right| .$$

$S(\theta)$ is called the efficient score of the parameters, and $M(\theta)$ is the matrix of the second partial derivatives of the log likelihood function. Staring with some initial estimates $\theta^{(0)}$, the additive correction $\Delta\theta^{(q+1)}$ at trial q+1 is calculated by

$$\Delta\theta^{(q+1)} = [M(\theta^{(q)})]^{-1} S(\theta^{(q)}), \quad q = 0, 1, \ldots$$

where $M(\theta^{(q)})$ and $S(\theta^{(q)})$ are evaluated at the given values, $\theta^{(q)}$, of the parameters. Then $\Delta\theta^{(q+1)}$ is added to $\theta^{(q)}$ as the next trial estimate. If the sequence of vector $\theta^{(q)}$ converges to a limit, that limit is the maximum likelihood estimate of the vector of parameters, say θ, except in trivial cases such as when the probabilities for some of the categories in the multinomial distribution are exactly zero (McHugh, 1956).

In this procedure, the main difficulty is the computation and inversion of the information matrix $M(\theta^{(q)})$ at each stage of approximation. If the sample is large, Rao (1950) suggests that $M(\theta)$ can be replaced by $-I(\theta)$, where $I(\theta)$ is the mean value of $M(\theta)$. That is

$$I(\theta) = \left\| \underline{E}\left(\frac{\partial^2 \log L}{\partial\theta_i \partial\theta_j}\right) \right\| = \left\| -\underline{E}\left(\frac{\partial \log L}{\partial\theta_i} \cdot \frac{\partial \log L}{\partial\theta_j}\right) \right\| .$$

$I(\theta)$ is called the "information matrix for the whole body of data at the assumed values" (Rao, 1950, p. 39). The iteration process using $-I(\theta)$ instead of $M(\theta)$ is known as the method of scoring. Rao (1973) suggests that the information matrix may be kept fixed after some stage, and only the efficient score need be calculated. This can reduce the computation considerably. At the final stage when stable values of the estimates are reached, the information matrix may be computed at the estimated values to obtain the variances and covariances of the estimators. These may be used in hypothesis testing for the estimators.

As demonstrated by Lazarsfeld and Henry (1968, p. 103-104), the method of scoring may be viewed as a large sample approximation method for the Newton-Raphson method. Since we are interested in applications of the model involving small sample sizes, e.g., 20, 30, 40, we shall only implement the Newton-Raphson method to estimate the parameters. The detailed efficient score matrix, $S(\theta)$, and the matrix of the second partial derivatives, $M(\theta)$, are summarized in Appendix I.

The Goodman method. Recently Goodman (1974a, 1974b; 1978, Chapter 8) presented a method of obtaining maximum likelihood estimates for a general latent class model. This method begins with trial values for the parameters, and then employs an iterative procedure which Goodman claims will converge under quite general conditions. Goodman's hypothesis 1 postulates one latent dichotomous variable that can explain or "account for" the relationships among a set of manifest dichotomous variables. This describes our response model for achievement test items, and we can identify our parameters k and the various values of $(1-x_t)$ with his.

Applying Goodman's method (1978, 1979), we arrive at the following procedure:

Starting with initial estimate $k^{(q)}, x_1^{(q)}, \ldots, x_m^{(q)}$, calculate a new trial value $k^{(q+1)}$ for the (q+1)th trial as:

$$k^{(q+1)} = 1 - \frac{f_0}{n} + \frac{f_0}{n} \cdot \frac{k^{(q)} \prod_{t=1}^{m} x_t^{(q)}}{1 - k^{(q)} + k^{(q)} \prod_{t=1}^{m} x_t^{(q)}} .$$

The new trial value $k^{(q+1)}$ is then used to calculate the various new estimates of x_t's:

$$x_t^{(q+1)} = 1 - \frac{f_t}{nk^{(q+1)}} , \quad t = 1, 2, \ldots, m$$

where $f_1, f_2, \ldots, f_m$ are the frequencies of correct responses on item t = 1, 2, ..., m, and f_0 is the frequency of examinees giving all incorrect responses to the m items.

This process is repeated for $k^{(q)}$ and $x_t^{(q)}$'s, q = 0, 1, 2, ..., allowing each to converge.

Although we can apply Goodman's method directly, it shoud be pointed out that, for this model, his method is similar to a type of iterative algorithm for maximum likelihood estimators identified by Dempster, Laird and Rubin (1977). It is known as the EM-algorithm. Each iteration of the EM-algorithm involves two steps: the expectation step (E-step) and the maximization step (M-step). The likelihood function, in our present case a multinomial distribution, is treated as "incomplete data." A new "complete data" specification of the likelihood function is specified by decomposing one of the categories into two. Then in the E-step, sufficient statistics for these two new categories are estimated, given the observed frequency values and a set of trial values for the parameters. The M-step then takes the estimated "complete data" (the original frequencies and the estimated sufficient statistics for the new categories) and estimates the parameters by the maximum likelihood method as though the estimated "complete data" were the observed data.

To be more precise, suppose we decompose the category or the response pattern of all incorrect responses, i.e., $Pr(w_0)$, into two categories:

$$Pr(A) = 1 - k,$$

and

$$Pr(B) = k \prod_{t=1}^{m} x_t$$

where

$$Pr(A) + Pr(B) = 1 - k + k \prod_{t=1}^{m} x_t = Pr(w_0)$$

with corresponding hypothetical frequencies f_A, f_B, and $f_A + f_B = f_0$. Thus the "complete data" consists of $[(f(w_\alpha), w_\alpha \neq w_0, f_A, f_B]$ and the "complete data" specification is

$$\underline{C} = \underline{C}(f(w_\alpha),\ f_A, f_B, w_\alpha \neq w_0 \mid k, x_1, \ldots, x_m)$$

$$= \frac{n! \prod_{w_\alpha \neq w_0} Pr(w_\alpha)^{f(w_\alpha)}}{f_A! f_B! \prod_{w_\alpha \neq w_0} f(w_\alpha)!} Pr(A)^{f_A} Pr(B)^{f_B} .$$

To define the EM-algorithm, we show how to find $k^{(q+1)}$, $x_1^{(q+1)}, \ldots, x_m^{(q+1)}$ from $k^{(q)}, x_1^{(q)}, \ldots, x_m^{(q)}$, where the superscript q denotes the values of $k, x_1, \ldots, x_m$ after q iterations for $q = 0, 1, 2, \ldots$. First we find the conditional expectation of f_A and f_B conditioned on $f(w_\alpha)$, and some trial estimates $k^{(q)}, x_1^{(q)}, \ldots, x_m^{(q)}$. Since $f_A + f_B = f_0$ and $Pr(A) + Pr(B) = Pr(w_0)$, the conditional distribution of f_A and f_B is

$$
\begin{aligned}
c &= c(f_A, f_B \mid f(w_\alpha), k^{(q)}, \ldots, x_m^{(q)}) \\
&= \frac{f_0!}{f_A! f_B!} \cdot \frac{Pr(A^{(q)})^{f_A} \cdot Pr(B^{(q)})^{f_B}}{Pr(w_0^{(q)})^{f_0}} \\
&= \frac{f_0!}{f_A!(f_0-f_A)!} \left|\frac{Pr(A^{(q)})}{Pr(w_0^{(q)})}\right|^{f_A} \cdot \left|1 - \frac{Pr(A^{(q)})}{Pr(w_0^{(q)})}\right|^{f_0-f_A} .
\end{aligned}
$$

This implies that the conditional distribution of f_A and f_B is just a binomial distribution with parameters f_0 and

$$
\frac{Pr(A^{(q)})}{Pr(w_0^{(q)})} .
$$

Thus the conditional expectations of f_A and f_B are

$$
\begin{aligned}
f_A^{(q)} &= \underline{E}(f_A \mid f(w_\alpha), k^{(q)}, x_1^{(q)}, \ldots, x_m^{(q)}) \\
&= f_0 \left|\frac{Pr(A^{(q)})}{Pr(w_0^{(q)})}\right| \\
&= f_0 \frac{1 - k^{(q)}}{1 - k^{(q)} + k^{(q)} \prod_{t=1}^{m} x_t^{(q)}} ,
\end{aligned}
$$

and

$$
\begin{aligned}
f_B^{(q)} &= \underline{E}(f_B \mid f(w_\alpha), k^{(q)}, x_1^{(q)}, \ldots, x_m^{(q)}) \\
&= f_0 \left|1 - \frac{Pr(A^{(q)})}{Pr(w_0^{(q)})}\right| \\
&= f_0 \frac{k^{(q)} \prod_{t=1}^{m} x_t^{(q)}}{1 - k^{(q)} + k^{(q)} \prod_{t=1}^{m} x_t^{(q)}} .
\end{aligned}
$$

The M-step then takes the estimated "complete data" $|(f(w_\alpha), w_\alpha \neq w_0), f_A^{(q)}, f_B^{(q)}|$ and estimates $k, x_1, \ldots, x_m$ by the method of maximum likelihood as though the estimated "complete data" were the observed data. Thus taking the partial derivatives of log C with respect to $k, x_1, \ldots, x_m$, and setting them equal to zero, we have

$$\frac{\partial \log C}{\partial k} = \frac{n - f_0}{k} - \frac{f_A^{(q)}}{1 - k} + \frac{f_B^{(q)}}{k} = 0,$$

and

$$\frac{\partial \log C}{\partial x_t} = - \frac{f_t}{1 - x_t} + \frac{n - f_t - f_0}{x_t} + \frac{f_B^{(q)}}{x_t} = 0,$$

for $t = 1, 2, \ldots, m$. Provided that $k^{(q)}, x_1^{(q)}, \ldots, x_m^{(q)}$ are not all equal to zero or one, we can solve these equations to yield

$$k^{(q+1)} = \frac{n - f_0 + f_B^{(q)}}{n},$$

$$x_t^{(q+1)} = 1 - \frac{f_t}{n - f_0 + f_B^{(q)}}$$

$$= 1 - \frac{f_t}{nk^{(q+1)}},$$

for $t = 1, 2, \ldots, m$. Starting with some initial estimates $k^{(0)}, x_1^{(0)}, \ldots, x_m^{(0)}$, the EM algorithm is defined by cycling back and forth between the E-step and M-step. This is identical to the Goodman method, since

$$k^{(q+1)} = \frac{n - f_0 + f_B^{(q)}}{n}$$

$$= 1 - \frac{f_0}{n} + \frac{f_0}{n} \cdot \frac{k^{(q)} \prod_{t=1}^{m} x_t^{(q)}}{1 - k^{(q)} + k^{(q)} \prod_{t=1}^{m} x_t^{(q)}}.$$

Two observations deserve to be made. The choice of the "complete data" specification, although arbitrary, has simplified the amount of algebraic manipulation considerably. This is partially due to the simplicity of the model which has a single response pattern (i.e., w_0) that is additive in parameters. By decomposing this category, we reduce the logarithm of the likelihood function into terms involving only one single parameter. Secondly, solving for the maximum likelihood equation for the "complete data," we could obtain an alternative solution for $k^{(q+1)}$:

$$k^{(q+1)} = \frac{n - f_A^{(q)}}{n} .$$

This is a simpler form and is consistent with the other equations. Preliminary comparison indicates that using this formula leads to the same numerical results as the other solution. However, we shall use the other solution since it is identical to Goodman's solution.

Dempster, et al., review many areas where the EM-algorithm has successfully been applied, or has potential applications. These include missing-value situations, applications to grouped, censored or truncated data, variance component estimations, iteratively reweighted least squares, fixed-mixture models, hyperparameter estimation and factor analysis. They also derive theorems showing the monotone behavior of the likelihood function and the convergence of the algorithm.

The Newton-Raphson method, the method of scoring and the EM-algorithm (or Goodman method) are competing numerical procedures for finding maximum likelihood estimates. These procedures start with some initial estimates of the parameters and systematically solve for better ones until convergence occurs. S.J. Haberman, one of the discussants of the paper by Dempster, et al., points out that the numerical stability and simplicity of implementation of the EM-algorithm are in its favor. However, Haberman notes that convergence of the EM-algorithm is often slow for latent structure models, and it does not provide estimates of asymptotic variances as the method of scoring does. The method of scoring is superior from the point of view of rate of convergence near a maximum, since it converges quardratically. However, it does not have the property of always increasing the likelihood, and can in some instances move toward a local minimum. Consequently, the choice of starting value may be more important under the method of scoring.

It is proposed to use the estimates obtained from the algebraic solution as initial estimates for the Newton-Raphson and the Goodman procedures. Besides being easy to calculate, the algebraic estimators are identical to the maximum likelihood estimators when m equals two. For m = 2, the Spearman solution for k, x_1 and x_2 are

$$\hat{k} = \frac{p_{01}p_{02}}{p_{12}} ,$$

$$\hat{x}_1 = 1 - \sqrt{\frac{p_{01}p_{02}/p_{02}}{p_{01}p_{02}/p_{12}}} = 1 - \frac{p_{12}}{p_{02}} ,$$

and similarly,

$$\hat{x}_2 = 1 - \frac{p_{12}}{p_{01}} .$$

For the method of maximum likelihood, there exist exact solutions for the estimators:

$$\hat{k} = \frac{f_1 f_2}{n(f_1 + f_2 + f_0 - n)} ,$$

$$\hat{x}_1 = 1 - \frac{f_1}{n\hat{k}} ,$$

and similarly,

$$\hat{x}_2 = 1 - \frac{f_2}{n\hat{k}} .$$

But these two sets of equations are consistent. To see this, note the definitions

$$p_{01} = \frac{f((11)) + f((10))}{n} = \frac{f_1}{n} ,$$

$$p_{02} = \frac{f((11)) + f((10))}{n} = \frac{f_2}{n} ,$$

$$p_{12} = \frac{f((11))}{n} ,$$

and

$$f((11)) + f((10)) + f((01)) + f((00)) = n.$$

Then the quantity $f_1 + f_2 + f_0 - n$ is equal to

$$\begin{aligned} f_1 + f_2 + f_0 - n &= 2f((11)) + f((10)) + f((01)) + f((00)) - n \\ &= f((11)) \\ &= np_{12}. \end{aligned}$$

Thus from the second set of formulas we have

$$\hat{k} = \frac{f_1 f_2}{n(f_1 + f_2 + f_0 - n)}$$

$$= \frac{p_{01} p_{02}}{p_{12}}$$

and similar results for x_1 and x_2. For more than two items, the Spearman method is simply an averaging procedure, averaging the numerators and the denominators separately for all possible two-item pairs. The estimators are obtained from the ratio of these two quantities. This may provide a good approximation for the maximum likelihood estimates.

We have discussed in some detail three different methods of estimating the parameters for the primitive model when it is applied to achievement tests with more than one item. These are the algebraic solution, the minimum least-square method applied to the algebraic solution and the method of maximum likelihood. Without any strong distributional assumption, it is very difficult to derive the exact sampling distribution of these estimators, particularly when a large number of items are involved. From statistical theory, however, we know that the maximum likelihood estimators, if they exist, are consistent and asymptotically normally distributed. For $m = 2$, it is possible to derive the asymptotic variance for the parameters, using the δ-Method (Hildebrand, Laing and Rosenthal, 1977, p. 291), e.g.,

$$\mathrm{Var}_{\infty}(\hat{k}) = \frac{k}{n} \left| 1 - k + \frac{x_1 x_2}{(1-x_1)(1-x_2)} \right| .$$

But when more than two items are involved, the algebra becomes intractable very quickly. The kind of achievement testing situation that we are interested in usually involves a small number of examinees, typically tests that are used in classrooms with thirty to forty students. In this situation, even the behavior of the maximum likelihood estimators has not been well studied. Hence, instead of trying to derive and specify the exact sampling distributions of these estimators, we propose to use the Monte Carlo Method to investigate the characteristics of these distributions. The development of empirical sampling distributions for situations we wish to study allows us to investigate the effect of sample size on these estimators, and to test the estimation procedures by explicitly assuming the response model from which we derive the procedures. It can also provide a basis for the application of the estimation procedure to "real" data gathered from "real" examinees.

By systematically varying several parameters and conditions, the Monte Carlo study may at least secure for us the beginning of a map that will define sampling variability of these estimators. We expect to generate samples over a number of conditions with different values of k, the various values of x_t's, the sample size n, and the number of items m. The means of these distributions will indicate whether or not the estimator is essentially unbiased, and the variances of these distributions will indicate the magnitude of the sampling variance of the estimator to be expected under the specified conditions. We shall also compare the different estimation procedures with respect to the characteristics of the sampling distributions and the efficiency of the procedures. In the next chapter, we will present the model and method for simulating examinees' response data and the plan for the Monte Carlo study.

The Monte Carlo study. A Monte Carlo method in the broad sense is any technique for solution of a model using random (or pseudorandom) numbers (Hammersley and Handscomb, 1964, p.2). The term model emphasizes that we are only studying some abstract representation of an object or a phenomenon and not the object or the phenomenon itself. Random numbers are stochastic variables which are uniformly distributed on the interval [0,1], and show stochastic independence. In this broad sense of the definition, Monte Carlo methods encompass three areas of applications (Kleijnen, 1974, pp. 9-12). The first area of application is concerned with the solution of deterministic problems with the aid of random numbers which are stochastic variables. A deterministic problem can be solved by the Monte Carlo method if the problem has some formal expression as a stochastic process. For example, this method can be used to determine the value of an integral, or multiple integrals.

The second area of application is distribution sampling. The purpose is to find the distribution of some of the parameters of a stochastic variable. The stochastic variable, the "output" variable, is a known function of one or more other stochastic "input" variables, which have known distributions. To estimate the distribution of this "output" variable, we draw a value of each of the "input" variables from their distributions and calculate the resulting value of the "output" variable. Such sampling is then repeated many times and this yields an estimate of the distribution. This method has been used in mathematical statistics for decades to study the robustness of some test statistics, for example.

The third area of application is stochastic simulation. Stochastic simulation is defined as experimentation with a model over time, involving the sampling of values of stochastic variables from their distributions. The definition of simulation in the broadest sense also includes deterministic simulation, experimenting with a model or system without the use of random numbers, as well as simulation with a physical or abstract model involving real people, such as business or military games. One example of stochastic simulation often mentioned in the literature is the simulation of a queuing system.

Kleijnen further suggests that the term Monte Carlo method should be reserved for the former two areas of application. While the distinction between the use of Monte Carlo methods to find the values of an integral and stochastic simulation is obvious, the distinction between distribution sampling and stochastic simulation is less clear. In distribution sampling, the "output" variable is usually a relatively simple function of the "input" variables. In stochastic simulation, however, this is a very complicated function which cannot be formulated explicitly short of a flow-chart or a computer program. In addition, the aim of distribution sampling is to find the distribution of estimators for parameters of a model or some statistics, whereas in stochastic simulation, the experimenter is more interested in the performance of the model under different circumstances.

In this context, the present study is a Monte Carlo study aimed at generating sampling distributions of the estimators described in the previous chapters. For fixed numbers of examinees and fixed numbers of items, we generate a sample of item response data using the item response model with selected values of the parameters k and x_t's. Then estimates of these parameters are calculated with the procedures described in the previous chapter from the sample of item response data. Such sampling is then repeated one hundred times and yields an estimate of the distribution for each of the estimators. In the following, we shall describe the method of generating the item response data.

An integral part of a Monte Carlo study is the use of random numbers. Purely random numbers can be generated from chance behavior of nature. Some of these physical processes are described in Shreider (1964, pp. 220-238). A very simple physical device, for example, is a ten-sided die for throwing a single digit number between 0 and 9. For a computer-based Monte Carlo study the purely random numbers, however, are unattractive compared with pseudorandom numbers. Pseudorandom numbers are generated by applying a deterministic algebraic formula which results in numbers that for practical purposes are considered to behave as random numbers, i.e., to be uniformly distributed and mutually independent. This independence implies that the "period" or "cycle length" is long enough, such that when a set of numbers is used for a study, it will not repeat itself. The "period" is the number of pseudorandom numbers that are generated before we obtain the same sequence of numbers again. The advantage of pseudorandom numbers is that the computer itself can generate sequences of numbers using an algebraic formula. In this way, no storage of a large table of random numbers is needed. In a large-scale study, this may save quite a bit of computer time necessary to read in and access the table. In addition, the same sequence of numbers can be reproduced at any time. This makes it possible to reproduce calculations exactly a second time when checking out a program.

A much-used formula for generating pseudorandom numbers is the multiplicative congruential method. A sequence of pseudorandom numbers, S_1, S_2, ..., is generated by repeatedly applying the following [illegible]:

$$S_i = aS_{i-1} \pmod{M}, \quad i = 1, 2, \ldots$$

$$S_0 = b.$$

This formula specifies that a new number, S_i, is the remainder of the product of the previous number S_{i-1} and a constant a divided by M. The starting value S_0 is called the "seed" number. The corresponding pseudorandom numbers, R_i, which must be between zero and unity, are obtained by dividing S_i by M. The choice of multiplier a and modulus M is intimately related to the "period" of the sequence. Knuth (1969, p. 155) summarizes the rules for choosing a and M so that the pseudorandom numbers will have maximum "period." Pseudorandom numbers are not random numbers because they are generated by means of deterministic processes. At best, they may appear to have the same properties as random numbers. Since there is no theorem showing that a sequence of numbers has the properties of random numbers, we have to rely on statistical tests to demonstrate the "randomness" of a sequence of numbers generated by a pseudorandom number generator. Typically, runs tests, serial tests, and various chi-square tests for independence are applied to relatively short sections of the pseudorandom sequence. Many of these tests are outlined by Knuth (1969). However, in their report of the comparisons of six different generators, Learmonth and Lewis (1973) suggest that the power of these classical tests to detect "poor" generators is suspect. And they demonstrate conclusively that the runs test has no utility as a test of randomness in pseudorandom number generators, while the usefulness of other tests is not clear.

For the present study, we have adopted one of the widely accepted multiplicative congruential generators available for 32-bit word computers as developed and tested by Learmonth and Lewis (1973). This generator uses $7^5 = 16807$ as the multiplier a, and $2^{31} - 1$ as the modulus M, thus achieving a maximum "period" of $2^{32} - 2$. Based on Learmonth and Lewis's extensive testing, this generator has been accepted as adequate for most purposes. It has been adopted by IMSL (International Mathematical and Statistical Library, 1979) as its basic generator. It has been suggested that the use of a shuffling scheme may improve the performance of the generator (Marsaglia and Bray, 1968). However, as Learmonth and Lewis point out, it is not clear how shuffling affects the mathematical structure of the sequence of numbers. We may have a generator which passes the statistical tests but has "poor" structural characteristics. Consequently, we have employed only unshuffled pseudorandom numbers for this study.

The model with which we generate the response data is derived from the primitive model. This has been described in some detail earlier. We shall only outline the model here and discuss how it can be applied to simulate examinee response data. The model can be summarized as follows.

> For a population of examinees for which an item domain of production items is appropriate, it is assumed that
>
> 1. Dichotomous Latent Classes. There are two undefined dichotomous latent classes with categories designated by (+) and (-). We assume that some non-zero proportion of examinee population belongs to the (+) category and the remaining proportion to the (-) category.
> 2. No "Guessing." A dichotomous production item administered to this population of examinees can be responded to correctly only by examinees in the (+) category. In other words we assume that it is not possible to "guess right." However, we permit errors on the part of examinees in the (+) category.

As before, we let

k = proportion of examinee population belonging to the (+) category,

x_t = conditional probability of an error by a member of the (+) category,

m = number of items,

n = number of examinees in the sample,

and

$$u_{\alpha t} = \begin{cases} 1, & \text{if examinee } \alpha \text{ responds correctly to item } t \\ 0, & \text{otherwise.} \end{cases}$$

The model assumes that the examinee's response to an item depends only on the latent category to which the examinee belongs. It does not depend on other known examinee characteristics, nor on any other characteristics of the item, nor on any other variables available to us. It follows that the probability of an examinee's response to an item is not altered by knowledge of the actual performance of other examinees. In addition, it follows that the probability of an examinee's response to an item is not altered by knowledge of his performance on other items. To generate the response data for a sample of examinees, we select the examinees randomly from the population. Since there are only two kinds of examinees, i.e., those who belong to the (+) category and those who belong to the (-) category, the selection of each examinee from the population is an independent Bernoulli trial with parameter k. This Bernoulli variable can easily be simulated on the computer by using the pseudorandom numbers and the following rule: The selected examinee belongs to the (+) category if $R \leq k$; otherwise, the (-) category if $R > k$, where R is a pseudorandom number, independently and uniformly distributed on the interval [0,1]. After we determine the latent category, we generate the examinee's responses to the m items. If the examinee belongs to the (+) category, we again make use of the Bernoulli variable. The examinee's response to item t will be correct if $R > x_t$, and incorrect if $R \leq x_t$, where R is a pseudorandom number. We repeat this process m times, each for a different item with different x_t. On the other hand, if the examinee belongs to the (-) category, the examinee's responses to the m items will all be incorrect, i.e., no "guess right."

By repeating this process n times, we generate the response data for n independent examinees. The responses are scored as 1's and 0's for correct and incorrect responses, respectively. Thus we obtain an m × n matrix of response data, and by applying the estimation procedures we developed in the previous chapters, we obtain the different estimates for the parameters k and the various x_t's. This represents one point in the sampling distribution of these parameters. For fixed values of k, x_t's, m and n, we shall generate 100 independent samples of response data, thus generating an equivalent number of points for the sampling distributions for each of the estimators.

A program written in FORTRAN Level H-Extended for generating the response data and for the four different estimation procedures is reported in Appendix II. To maintain the independence characteristic of a sequence of pseudorandom numbers, the program uses one continuous sequence of pseudorandom numbers for generating all the simulated response data presented in this study. All the calculations are done in double precision or in integer when permissible. The outputs are rounded to five decimal places. Starting with the specified parameters, the program proceeds to generate the sample of response data. This is done by the subroutine GEN which calls the IMSL subroutine GGUB (IMSL, 1979) for the sequence of pseudorandom numbers. Then subroutine FORM is used to calculate the marginal frequencies and the joint-frequencies of correct responses from the response data. In addition, the frequencies of simulated examinees having all incorrect responses to the m items are calculated. Next, estimates for the Spearman solution are calculated with the subroutine SPEAR. These estimates are served as initial estimates for the Minres, Goodman and Newton-Raphson procedures (subroutines MINRES, GOODMX and MAXLIK, respectively). For the Minres procedure, the following criterion is used to test for convergence:

$$\max_{i=0,\ldots,m} \left| a_i^{(q)} - a_i^{(q-1)} \right| \leq \underline{d}.$$

For the Goodman procedure and the Newton-Raphson method, we use

$$\max_{i=0,1,\ldots,m} \left|\theta_i^{(q)} - \theta_i^{(q-1)}\right| \le \underline{d},$$

where

$$\theta_0 = k, \quad \theta_i = x_i, \quad i = 1, 2, \ldots, m$$

as a test for convergence. The convergence tolerance limit $\underline{d}$ is set at 10^{-6}. In the Newton-Raphson method, the additive corrections are calculated using an IMSL subroutine LINV3F (IMSL, 1979). This subroutine solves for additive corrections using the LU decomposition of the matrix $M(\theta)$ and performs an in-place inversion for $M(\theta)$. It can also return with the determinant of the matrix $M(\theta)$.

During the development of the program, it was discovered that when the sample size n is small, e.g., less than or equal to 40, the Spearman procedure may produce estimates that are equal to zero or unity. These estimates are not admissible to the likelihood equations. In some instances, these inadmissible values may lead to singularity of the matrix $M(\theta)$ for the Newton-Raphson method. One way to get around this problem is to reset these estimates to an arbitrary value, say .5, and allow the procedure to converge on its own. For the Goodman method and the Newton-Raphson method, however, this does not lead to a convergent result. On the other hand, if these estimates are fixed at a value close to the boundaries of the interval (0,1), convergence occures. The resulting estimates for the other parameters may be termed as "conditional," i.e., conditional on some of the estimators being fixed. The subroutine MAXFIX is written for this purpose. When an initial estimate is zero or unity, the subroutine MAXFIX first sets the value to .5 and returns the control to the calling estimation subroutines (either GOODMX or MAXLIK). At the same time a counter is set to indicate the initial estimate is inadmissible. If after one iteration the new estimate is outside the interval (0,1), the subroutine MAXFIX is called again. This time and for subsequent trials, the estimate will be fixed at a value close to the boundaries. If the initial estimate is zero, it will be set to $\underline{d} \times 10^{-1}$. If the initial estimate is unity, it will be set to $1 - \underline{d} \times 10^{-1}$. After this subroutine MAXFIX is installed, the Goodman method and the Newton-Raphson method both are able to converge to some estimates under almost all conditions. The theoretical implication of this procedure of fixing the estimators is not clear, however.

Given the model for generating the response data, and the different procedures for estimating the parameters, the present study has selected a number of conditions under which we simulated the response data and obtained the estimates using the different estimation procedures. These conditions reflect our interest in the application of the kind of achievement tests commonly administered in classroom situations. Thus, we have selected to simulate response data of sample size 20, 30, and 40, and test length of 10 and 15 items each. In addition, we have selected the sample size of 120 for comparison. For the parameter k, we have selected .3, .5, .7, .75 and .8, which cover a range of the possible values for k. For the various values of x_t's, we have selected six sets of values. For three of these sets, all the values of x_t's were constant and set at .2, .4, and .5, whereas the x_t's for the other three sets were selected from the ranges .1 to .85, .05 to .5, and .5 to .95. These conditions are summarized in Table 1. We generated 100 independent samples of response data under each combination of the parameters described above, or a total of 240 different combinations.

Table 1

Summary of the Parameters Used for the Monte Carlo Study

Parameter	Descriptions	Values Selected
n	sample size	20, 30, 40, 120
m	test length	10, 15
k	proportion of examinees in the (+) category of the latent trait	.3, .4, .5, .7, .75, .8
x_t's	conditional probability of an error by examinees in the (+) category	constant: .2 constant: .4 constant: .5 range: .1 to .85 range: .05 to .5 range: .5 to .95

Results. The results of the Monte Carlo study are summarized here and in Appendix III. The study was performed on the Itel AS/6 at the University of California, Santa Barbara, using the program described in Appendix II. Additional statistical analyses were performed using the Statistical Analysis System 79.2A (SAS Inc., 1979). In the present study, instead of trying to cover all possible combinations of the parameters involved, we have selected situations which would be likely to occur in classroom testing. The estimation procedures developed previously could be applied to an unlimited number of items and an unlimited number of students; however, we have limited our focus to shorter tests, e.g., tests with 10 or 15 items, and a small sample size, e.g., 20, 30 or 40 students each. For comparison, we have also included a sample size of 120 so that we could identify the large sample properties of the estimation procedures. On the other hand, for the parameter k, we have selected the values of .3, .5, .7, .75 and .8. We anticipated that for classroom testing, the values of k would be likely to be greater than .5 and we have included the value of .3 for comparison.

The choices of the values of x_t's were the most problematic. Since we did not have any notion as to how the different values of x_t's would be distributed within an item domain, we decided on two possible situations: one in which the x_t's would be constant for all items and one in which the x_t would be varied over the possible number of items. At the same time, we anticipated that x_t's would be small in applications. Thus, for the constant x_t's conditions, we selected the values .2, .4 and .5; and for the varied x_t's, we selected the values from the range of .1 to .85, .05 to .50, and .5 to .95. The large values were included for comparison purposes. Note that values selected from the range .05 to .50 were complements of those selected from the range .50 to .95. The choices of x_t's have been arbitrary. We have included the different sets of x_t's mainly to see how they would affect the estimations of the parameter k. In this sense, the x_t's could properly be treated as nuisance parameters in the model.

The Monte Carlo study focused on two points: how the different estimation procedures performed under the different conditions outlined above and how they compared with one another. To examine these estimators, we have used the mean squared errors and the average deviations of the estimates for the different combinations. We also attempted to identify systematic differences in the estimations across the different combinations. In addition, we inspected the number of trials needed to reach convergence of the three iterative procedures.

For each of the 240 different combinations of test length, sample size, parameter k and various x_t, we generated 100 replications of response data. The different values of test length (m), sample size (n), parameters k and x_t's used in this study were summarized in Table 1 above. The four different estimation procedures described above were then applied to each of the 24,000 replications of simulated response data.

The results of the Monte Carlo study are summarized in Appendix III for each of the combinations. In each of the 240 tables, we have summarized the results for each of the estimators over the 100 replications. For example, for a ten-item test, there were eleven parameters to be estimated, i.e., k, x_1, x_2, ..., x_{10}. Applying the four different estimation procedures (Spearman, Minres, Goodman, and Newton-Raphson), we generated 4 × 11 different distributions of estimates. The means and standard deviations were reported for each of these distributions. In addition, the sum of squared residuals for the Minres procedure and the number of trials to convergence for the three iterative procedures were summarized in terms of the mean and standard deviations for each combination.

Convergence of the iterative procedures. The Minres, Goodman, and Newton-Raphson procedures are all iterative. In all three cases, the Spearman solution was used for the initial estimates. To test for convergence, the tolerance limit was set at 10^{-6} with the maximum number of iterations allowed for each procedure fixed at 20. Of the 24,000 different replications, only 13, 22 and 438 replications failed to converge within these limits, for the Minres, Goodman, and Newton-Raphson procedures, respectively. The failures occurred when the values selected for the different x_t's were restricted to be at least 0.50. The number of failures to converge for this choice of x_t's are summarized in Table 10.1 for the various combinations of m, n, and k. These failures were most likely to occur when the number of items used was small (m = 10), the sample size was small (n = 20, 30 and 40), and k was small.

About 99% of the replications across all combinations converged by the tenth trial for all three procedures. The distributions of the number of trials to convergence are shown in Table 10.2. The modes were, respectively, 7, 2 and 5, for the Minres, Goodman and Newton-Raphson procedures. The modes for each combination were also the smallest for the Goodman procedure in general. As shown in Tables 10.3 a-c, except for the cases where the x_t's were restricted to be at least .50, the majority of the modes for the Goodman procedure were two and three trials. The modes seemed to be the least affected by the differences in k and the most affected by the differences in the selections of x_t's for all three procedures. When the x_t's were restricted to be at least .50, more trials were required for convergence. As indicated earlier, since we set the maximum number of iterations to convergence at 20, we also observed a number of replications failing to converge. One possible explanation for the large number of non-convergence for this particular choice of x_t's could be that the simulated data contained a large number of incorrect or zero responses.

For any combination of m, n, k and x_t's, it was theoretically plausible to obtain a response data matrix with only zeros or ones. These situations, however, were more likely to happen when the choices of the parameters tended toward extremes. The most extreme condition selected for the present study occurred when the x_t's were restricted to be at least .50 and k was small. For example, the model predicted that for any randomly selected student, the probabilities of obtaining all-zero and all-one response patterns were respectively,

$$\text{Pr(all-zero response pattern)} = 1 - k + k \prod_{t=1}^{m} x_t,$$

and

$$\text{Pr(all-one response pattern)} = k \prod_{t=1}^{m} (1 - x_t).$$

Thus for a group of n students, the probabilities of observing an all-zero and an all-one response data matrix would be

$$\text{Pr(all-zero entries)} = \left|1 - k + k \prod_{t=1}^{m} x_t\right|^n,$$

and

$$\text{Pr(all-one entries)} = \left|k \prod_{t=1}^{m} (1 - x_t)\right|^n.$$

For $k = .30$, $m = 10$, $n = 20$ and the set of x_t's being at least .50, i.e., .65, .75, .60, .80, .90, .95, .50, .70, .85 and .55, the probability of observing a response data matrix with only zeros was approximately 1.0543×10^{-3}, while the probability of observing only ones in the response data matrix was approximately 7.7834×10^{-145}. Similarly, we could calculate the probabilities for any number of ones or zeros in the response data matrix. This would simply be the sampling distribution of the number of ones or zeros in the response data matrix. While it would be difficult to derive the exact sampling distribution, we could obtain the mean and variance of such a distribution through the multinomial distribution of the response patterns.

Let the random variable, Z, be the number of zeros in the response data matrix, then the mean and variance of Z are

$$\underline{E}(Z) = mn(1 - k + k\bar{x}),$$

and

$$\begin{aligned}\sigma^2(Z) &= \underline{E}(Z - E(Z))^2 \\ &= m^2nk(1 - \bar{x})(1 - k + k\bar{x}) - (m - 1)nk(m\bar{x}(1 - \bar{x}) + s_x^2)\end{aligned}$$

where

$$\bar{x} = \frac{\sum_{t=1}^{m} x_t}{m} = \text{the average value of } x_t,$$

and

$$s_x^2 = \frac{\sum_{t=1}^{m} (x_t - \bar{x})^2}{m - 1} = \text{the variance of } x_t.$$

Note that the random variable of number of ones in the response data matrix would simply be $mn - Z$. For the present example, $\bar{x}$ and s_x^2 were respectively 0.725 and 0.0229. Thus the mean and variance for Z were 183.5 and 42.49, respectively. Since the total number of entries in the response data matrix was $m \times n = 200$, this suggested that the distribution of Z could be negatively skewed. That is, it would be more likely to observe response data matrices with a large number of zero entries. To determine the actual shape of the distribution, we would also need to know the higher moments of the distribution. This is beyond the scope of the present discussion which is merely to point out that the failures of convergence might be affected by this distribution. Interestingly, given the set of x_t's restricted to be at least 0.50, we could predict the number of non-convergences for the Newton-Raphson procedure by using a third-order equation in $\sigma(Z)$, the standard deviation of Z, alone. It accounted for about 88.4% of the variation in the number of non-convergences. The mean and standard deviation of Z were also reported in Table 10.1. If the number of non-convergences were related to the distribution of Z, we would similarly expect the same to occur when the response data matrix has a disproportionate number of ones. For the combinations of the parametric values selected for this study, however, none seemed to reach as extreme a condition for the distribution of the number of ones. The worst

Table 10.1

Number of Non-Convergences for the Three Iterative Procedures When the x_i's Were Restricted to be at Least 0.50

n	h	m=10 items					m=15 items				
		Number of Non-Convergences for the Three Iterative Procedures*			Number of Zero Entries in Response Data Matrix (Z)		Number of Non Convergences for the Three Iterative Procedures*			Number of Zero Entries in Response Data Matrix (Z)	
		(1)	(2)	(3)	value (E(Z))	dev (σ(Z))	(1)	(2)	(3)	value (E(Z))	dev (σ(Z))
	30	5	3	50	183.5	6.52	1	1	15	274.8	9.50
	50	3	1	41	172.5	7.46	0	0	4	258.1	10.74
20	70	1	0	32	161.5	7.54	0	0	4	241.3	10.59
	75	1	1	31	158.5	7.43	0	0	3	237.1	10.35
	80	0	5	32	156.5	7.27	0	0	3	232.9	10.01
	30	2	0	43	275.3	7.98	0	0	9	412.3	11.64
	50	0	0	30	258.8	9.14	0	0	2	387.1	13.15
30	70	0	1	14	242.3	9.23	0	0	1	361.9	12.97
	75	0	0	20	238.1	9.10	0	0	0	355.6	12.67
	80	0	6	22	234.0	8.90	0	0	0	349.3	12.25
	30	0	0	29	367.0	9.22	0	0	2	549.7	13.44
	50	0	1	14	345.0	10.55	0	0	0	516.1	15.19
40	70	0	0	4	323.0	10.66	0	0	0	482.6	14.98
	75	0	2	18	317.5	10.51	0	0	0	474.2	14.63
	80	0	1	11	312.0	10.28	0	0	1	465.8	14.15
	30	0	0	3	1101.0	15.97	0	0	0	1649.0	27.28
	50	0	0	0	1035.0	18.28	0	0	0	1548.4	26.31
120	70	0	0	0	969.0	18.46	0	0	0	1447.7	15.95
	75	0	0	0	952.0	18.19	0	0	0	1422.5	25.34
	80	0	0	0	936.0	17.80	0	0	0	1397.4	24.51

*The Three Iterative Procedures Are:
(1) the Minres Procedure,
(2) the Goodman Procedure, and
(3) the Newton-Raphson Procedure.

BEST COPY AVAILABLE

Table 10.2

Frequency Distributions of the Number of Trials to Convergence for the Three Iterative Procedures Across All Combinations

No. of Trials to Covergence	Estimation Procedures		
	Minres	Goodman	N. - R.
1	12		
2		11346	
3		7481	
4	116	1856	2501
5	1265	1104	16086
6	6212	486	3589
7	9656	457	730
8	5397	462	226
9	750	310	117
10	267	193	86
11	143	120	50
12	72	59	49
13	32	28	26
14	26	23	25
15	16	20	29
16	4	12	19
17	9	8	12
18	4	9	8
19	4	4	9
20	2		
> 20	13	22	438
Total	24000	24000	24000

BEST COPY AVAILABLE

Table 10.3a

Modes of Frequency Distribution of the Number of Trials to Convergence for Each Combination for the Minres Procedure

n	h	m=10 items						m=13 items					
		Constant s_t's			Varied s_t's			Constant s_t's			Varied s_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	7	8	8	8	7	8	8	7	7	7	6	8
	0.50	7	7	8	8	7	8	8	7	7	7	6	8
	0.70	7	7	8	8	7	8	8	7	7	7	6	8
	0.75	6	7	7	8	7	9	8	7	7	7	6	8
	0.80	6	7	7	8	7	8	8	7	7	7	6	8
30	0.30	6	7	8	8	7	8	8	7	7	7	6	8
	0.50	6	7	7	8	7	8	8	7	7	6	6	8
	0.70	6	7	7	8	7	8	8	7	7	7	6	8
	0.75	6	7	7	8	7	8	8	7	7	6	6	8
	0.80	6	7	7	8	7	8	7	7	7	7	6	8
40	0.30	6	7	7	8	7	8	8	7	7	6	6	8
	0.50	6	7	7	8	7	8	7	7	7	6	6	8
	0.70	6	7	7	8	7	8	8	7	7	6	6	8
	0.75	6	7	7	8	7	8	7	7	7	6	6	8
	0.80	6	7	7	8	7	8	8	7	7	6	6	8
120	0.30	6	7	7	7	7	8	7	6	7	6	5	7
	0.50	6	7	7	7	6	8	7	6	7	6	5	7
	0.70	5	6	7	7	6	8	7	6	6	6	5	7
	0.75	5	6	7	7	6	8	7	6	6	6	5	7
	0.80	5	6	7	7	6	8	7	6	6	6	5	7

BEST COPY AVAILABLE

Table 10.3b

Modes of Frequency Distribution of the Number of Trials to Convergence for Each Combination for the Goodman Procedure

n	h	m=10 items						m=15 items					
		Constant x_t's			Varied x_t's			Constant x_t's			Varied x_t's		
		.20	.40	50	.10 to .85	.05 to .50	.50 to 95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
	0.30	3	3	3	3	3	7	3	3	3	2	2	4
	0.50	2	3	4	3	3	6	2	2	3	2	2	4
20	0.70	2	3	4	3	3	8	2	2	3	2	2	5
	0.75	2	3	4	3	2	7	2	2	3	2	2	5
	0.80	2	3	4	3	2	8	2	2	3	2	2	5
	0.30	2	3	3	3	3	8	2	2	3	2	2	4
	0.50	2	3	4	3	3	8	2	2	3	2	2	5
30	0.70	2	3	4	3	2	8	2	2	3	2	2	5
	0.75	2	3	4	3	2	8	2	2	3	2	2	5
	0.80	2	3	4	3	2	7	2	2	3	2	2	5
	0.30	2	3	4	3	3	7	2	2	3	2	2	5
	0.50	2	3	4	3	2	7	2	2	3	2	2	5
40	0.70	2	3	4	3	2	8	2	2	3	2	2	5
	0.75	2	3	4	3	2	8	2	2	3	2	2	5
	0.80	2	3	4	3	2	8	2	2	3	2	2	5
	0.30	2	3	4	3	2	8	2	2	3	2	2	5
	0.50	2	3	3	3	2	7	2	2	3	2	2	4
120	0.70	2	3	4	3	2	7	2	2	3	2	2	5
	0.75	2	3	4	3	2	8	2	2	3	2	2	5
	0.80	2	3	4	3	2	9	2	2	3	2	2	5

BEST COPY AVAILABLE

Table 10.3c

Modes of Frequency Distribution of the Number of Trials to Convergence for Each Combination for the Newton-Raphson Procedure

n	h	m=10 items						m=15 items					
		Constant π_t's			Varied π_t's			Constant π_t's			Varied π_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	5	5	6	5	5	9	5	5	6	5	5	6
	0.50	5	5	5	6	5	7	5	5	5	5	5	6
	0.70	5	5	5	5	5	6	5	5	5	5	5	6
	0.75	5	5	5	5	5	6	5	5	5	5	5	6
	0.80	5	5	5	5	5	6	5	5	5	5	5	6
30	0.30	5	5	5	5	5	6	5	5	5	5	5	6
	0.50	5	5	5	5	5	6	5	5	5	5	5	6
	0.70	5	5	5	5	5	6	5	5	5	5	5	6
	0.75	5	5	5	5	5	6	5	5	5	5	5	6
	0.80	5	5	5	5	5	6	5	5	5	5	5	6
40	0.30	5	5	5	5	5	6	5	5	5	5	5	6
	0.50	5	5	5	5	5	6	5	5	5	5	5	6
	0.70	5	5	5	5	5	6	5	5	5	5	5	6
	0.75	5	5	5	5	5	6	5	5	5	5	5	6
	0.80	5	5	5	5	5	6	5	5	5	5	5	6
120	0.30	5	5	5	5	5	6	5	5	4	5	5	6
	0.50	5	4	4	5	5	5	5	4	4	5	5	5
	0.70	5	4	4	5	5	5	5	4	4	5	4	5
	0.75	5	4	4	5	5	5	5	4	4	5	4	5
	0.80	5	4	4	5	5	5	5	4	4	5	4	5

BEST COPY AVAILABLE

combination possible, for example, was when $m = 10$, $n = 20$, $k = .8$ and the x_t's were fixed at 0.20. The mean and variance for the distribution of the number of ones, i.e., $mn - Z$, were respectively 128.0 and 230.40. By comparison, the mean of this distribution was closer to the middle range of all possible values, i.e., between 0 and 200. The variance of the distribution was also much greater. None of the replications generated from this combination failed to converge. Though inconclusive, this seemed to lend support to the contention that the non-convergence might be related to the distribution of the number of zeros or ones in response data matrix.

Sum of squared residuals for the Minres procedure. For the Minres procedure, the average sum of squared residuals (SSR's) for each combination ranged from 0.00221 to 0.22422. The means for each combination are displayed in Table 10.4. Several trends were evident. The average SSR's increased with k and the number of items, m, but decreased with the increase in sample size n, as summarized in Table 10.5a. The average SSR's also varied with the choices of x_t's. In Table 10.5b, the SSR's were summarized by averaging over possible combinations of k and n for each set of x_t's. Note that the average SSR's were greater for the 15-item test than for the 10. The average SSR's increased with the average of x_t's, x, when the x_t's were constant for all items, while remaining relatively constant when the x_t's varied. The values of the SSR's seem to point toward the possibility that the SSR's could be a quadratic function in $\bar{x}$ with the maximum SSR's occurring when $\bar{x}$ was close to 0.50. This was particularly evident for the 15-item test and with varying x_t's. Unfortunately, for constant x_t's, the largest value selected was 0.50. While the values of the average SSR's did seem to reach a plateau when $\bar{x} = 0.50$ for both 10- and 15-item tests, more information would be needed to determine if the SSR's were indeed a quadratic function of $\bar{x}$ (and possibly of s_x^2 also).

Estimates of k. The four estimators for k were found to be very similar. Table 10.6 summarizes the correlations between these estimates across the 24,000 replications. They range from 0.99270--between the Spearman and the Newton-Raphson procedures--and 0.99835--between the Spearman and the Minres procedures. This might be partially due to the use of the Spearman procedure for initial estimates for the other three iterative procedures. It should be noted that some of the estimates of k were greater than unity for the Spearman and Minres procedures. To compare the estimates, the mean squared errors (MSE's) and the average deviations (AD's) of the estimates from the parametric values of k were calculated for each combination, i.e., for fixed k, m, n, and x_t's. The MSE's are summarized in Tables 10.7 a-d for the four procedures. The AD's are summarized in Table 10.13 a-d.

The average MSE's were 0.0063018, 0.0063271, 0.0060072, and 0.0064680 over all combinations of k, m, n, and x_t's, for the Spearman, Minres, Goodman and Newton-Raphson procedures, respectively. The MSE's for each combination are summarized in Tables 10.7 a-d, and the frequency distributions of these MSE's are displayed in Table 10.8. As shown in Table 10.8, the MSE's fell between the intervals with mid-points 0.001 and 0.029. While the Goodman procedure had the narrowest range, from 0.001 to 0.014, the Newton-Raphson procedure had the widest. For all four procedures together, only seven of the MSE's were outside the interval with mid-point 0.014. Inspecting Tables 10.7 a-d, it was found that the MSE's within

Table 10.4 .

Average Sum of Squared Residuals for the Minres Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant π_i's			Varied π_i's			Constant π_i's			Varied π_i's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.01209	0.02689	0.03066	0.01674	0.01420	0.01418	0.02992	0.06320	0.06467	0.04067	0.03846	0.03780
	0.50	0.02250	0.04999	0.04994	0.02859	0.02911	0.02798	0.05565	0.12366	0.12641	0.08163	0.07253	0.07152
	0.70	0.03282	0.06725	0.07367	0.03865	0.03923	0.03792	0.07710	0.17481	0.19298	0.11580	0.10249	0.09794
	0.75	0.03290	0.07859	0.08264	0.04026	0.04314	0.04033	0.08101	0.18935	0.20387	0.12487	0.11491	0.10715
	0.80	0.03657	0.08371	0.08779	0.04384	0.04418	0.04635	0.08796	0.20165	0.22422	0.13590	0.11677	0.11927
30	0.30	0.00881	0.01861	0.02031	0.01002	0.01031	0.00991	0.02050	0.04832	0.05115	0.03355	0.02786	0.02548
	0.50	0.01548	0.03271	0.03605	0.01710	0.01794	0.01745	0.03559	0.08531	0.08871	0.05692	0.04949	0.04733
	0.70	0.02000	0.04772	0.05178	0.02584	0.02715	0.02704	0.05305	0.11763	0.12884	0.08065	0.06891	0.07100
	0.75	0.02257	0.05272	0.05567	0.02908	0.02906	0.02860	0.05476	0.12468	0.14074	0.08852	0.07530	0.07695
	0.80	0.02447	0.05353	0.06057	0.03171	0.03137	0.02993	0.06040	0.13712	0.14534	0.09298	0.08255	0.08102
40	0.30	0.00672	0.01542	0.01546	0.00729	0.00885	0.00825	0.01543	0.03730	0.04199	0.02546	0.02261	0.02134
	0.50	0.01097	0.02521	0.02752	0.01432	0.01538	0.01358	0.02767	0.06241	0.06988	0.04216	0.03889	0.03612
	0.70	0.01554	0.03541	0.03945	0.02018	0.02004	0.02003	0.04016	0.09154	0.09873	0.06165	0.05317	0.05320
	0.75	0.01660	0.04016	0.04329	0.02112	0.02169	0.02144	0.04405	0.09496	0.10790	0.06447	0.05765	0.05704
	0.80	0.01833	0.04174	0.04591	0.02215	0.02435	0.02170	0.04437	0.10383	0.10985	0.06964	0.06072	0.06068
120	0.30	0.00221	0.00539	0.00568	0.00280	0.00294	0.00285	0.00587	0.01313	0.01440	0.00869	0.00755	0.00769
	0.50	0.00387	0.00894	0.00967	0.00463	0.00495	0.00486	0.00942	0.02197	0.02386	0.01477	0.01289	0.01280
	0.70	0.00542	0.01273	0.01376	0.00666	0.00687	0.00691	0.01382	0.03085	0.03399	0.02054	0.01809	0.01829
	0.75	0.00607	0.01330	0.01454	0.00742	0.00741	0.00743	0.01446	0.03382	0.03582	0.02225	0.01965	0.01979
	0.80	0.00615	0.01400	0.01543	0.00799	0.00785	0.00825	0.01542	0.03472	0.03826	0.02398	0.02162	0.02112

Table 10.5a

Average Sum of Squared Residuals for the Minres Procedure by k and Sample Size (n)

k	n=20	n=30	n=40	n=120
0.30	0.032457	0.023736	0.018844	0.006600
0.50	0.061625	0.041674	0.032008	0.011052
0.70	0.087563	0.059968	0.045757	0.015662
0.75	0.094919	0.064889	0.049198	0.016838
0.80	0.102351	0.069248	0.051939	0.017901

Table 10.5b

Average Sum of Squared Residuals for the Minres Procedure
by the Sets of x_t's and Number of Items (m)

m		Constant x_t's			Varied x_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
10	Ave. SSR	0.0160039	0.0362058	0.0389891	0.0198197	0.0203010	0.0197494
	Ave. x	0.20	0.40	0.50	0.4250	0.2750	0.7250
	s.d. of x	---	---	---	0.2751	0.1514	0.1514
15	Ave. SSR	0.0393352	0.0895137	0.0970801	0.0602545	0.0531057	0.0521776
	Ave. x	0.20	0.40	0.50	0.4567	0.2800	0.7200
	s.d. of x	---	---	---	0.2344	0.1360	0.1360

Table 10.6

Correlations between the Estimates of k from the Four Estimation Procedures

(Number of Cases in Parantheses)

	Minres	Goodman	Newton-Raphson
Spearman	0.99835 (23987)	0.99652 (23978)	0.99270 (23562)
Menres		0.99621 (23971)	0.99279 (23562)
Goodman			0.99571 (23551)

Table 10.7a

Mean Squared Errors of the Estimates of h from the Spearman Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant a_t's			Varied a_t's			Constant a_t's			Varied a_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.01007	0.00932	0.00827	0.01279	0.01165	0.01387	0.01075	0.01306	0.01070	0.01075	0.01098	0.01125
	0.50	0.01207	0.01320	0.01281	0.01046	0.01195	0.01307	0.01354	0.01341	0.01379	0.01245	0.01073	0.01293
	0.70	0.00905	0.01319	0.01168	0.01110	0.01135	0.01450	0.00902	0.01143	0.01187	0.01112	0.00949	0.01215
	0.75	0.00886	0.00626	0.00927	0.00923	0.00989	0.01561	0.00921	0.00891	0.00783	0.00849	0.00743	0.01005
	0.80	0.00733	0.00890	0.01023	0.00798	0.00863	0.01267	0.00777	0.00829	0.00952	0.00876	0.00896	0.00950
30	0.30	0.00584	0.00768	0.00758	0.00608	0.00537	0.00724	0.00758	0.01077	0.00788	0.00607	0.00712	0.00660
	0.50	0.00915	0.01178	0.01231	0.00818	0.00740	0.00959	0.00806	0.00790	0.00904	0.01023	0.00875	0.00950
	0.70	0.00727	0.00755	0.00865	0.00764	0.00571	0.01237	0.00835	0.00684	0.00694	0.00740	0.00673	0.00931
	0.75	0.00698	0.00576	0.00713	0.00803	0.00694	0.00762	0.00588	0.00634	0.00601	0.00546	0.00801	0.00663
	0.80	0.00503	0.00540	0.00415	0.00387	0.00535	0.00937	0.00445	0.00577	0.00564	0.00501	0.00648	0.00651
40	0.30	0.00597	0.00484	0.00542	0.00461	0.00507	0.00606	0.00613	0.00472	0.00543	0.00459	0.00559	0.00617
	0.50	0.00584	0.00680	0.00668	0.00589	0.00755	0.00784	0.00519	0.00611	0.00486	0.00738	0.00769	0.00745
	0.70	0.00477	0.00567	0.00489	0.00585	0.00545	0.00954	0.00587	0.00508	0.00441	0.00527	0.00588	0.00666
	0.75	0.00519	0.00446	0.00481	0.00528	0.00489	0.00755	0.00380	0.00510	0.00372	0.00585	0.00486	0.00432
	0.80	0.00324	0.00538	0.00389	0.00394	0.00315	0.00699	0.00373	0.00434	0.00391	0.00329	0.00414	0.00464
120	0.30	0.00195	0.00161	0.00172	0.00183	0.00197	0.00174	0.00189	0.00175	0.00176	0.00146	0.00202	0.00195
	0.50	0.00208	0.00243	0.00198	0.00200	0.00238	0.00170	0.00167	0.00177	0.00216	0.00169	0.00210	0.00242
	0.70	0.00218	0.00185	0.00148	0.00217	0.00165	0.00225	0.00168	0.00187	0.00213	0.00167	0.00168	0.00166
	0.75	0.00139	0.00157	0.00191	0.00181	0.00153	0.00246	0.00170	0.00177	0.00147	0.00165	0.00173	0.00226
	0.80	0.00130	0.00160	0.00168	0.00129	0.00139	0.00254	0.00134	0.00104	0.00112	0.00146	0.00131	0.00142

BEST COPY AVAILABLE

Table 10.7b·

Mean Squared Errors of the Estimates of b from the Minres Procedure for Each Combination

n	b	m=10 items						m=15 items					
		Constant s_t's			Varied s_t's			Constant s_t's			Varied s_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.01003	0.00945	0.00822	0.01257	0.01167	0.01345	0.01073	0.01307	0.01076	0.01065	0.01103	0.01143
	0.50	0.01206	0.01294	0.01297	0.01034	0.01187	0.01294	0.01351	0.01333	0.01411	0.01244	0.01066	0.01326
	0.70	0.00898	0.01309	0.01183	0.01077	0.01122	0.01481	0.00902	0.01135	0.01170	0.01097	0.00954	0.01338
	0.75	0.00884	0.00623	0.00888	0.00938	0.00973	0.01925	0.00921	0.00883	0.01018	0.00841	0.00745	0.01079
	0.80	0.00731	0.00834	0.01051	0.00773	0.00857	0.01247	0.00774	0.00833	0.00943	0.00852	0.00903	0.01039
30	0.30	0.00582	0.00778	0.00758	0.00607	0.00529	0.00795	0.00757	0.01069	0.00806	0.00613	0.00710	0.00679
	0.50	0.00916	0.01169	0.01208	0.00824	0.00743	0.01062	0.00804	0.00787	0.00917	0.01026	0.00875	0.01016
	0.70	0.00728	0.00756	0.00851	0.00751	0.00571	0.01182	0.00837	0.00682	0.00686	0.00744	0.00672	0.00894
	0.75	0.00699	0.00565	0.00703	0.00810	0.00681	0.00766	0.00587	0.00645	0.00614	0.00531	0.00800	0.00641
	0.80	0.00502	0.00545	0.00392	0.00387	0.00535	0.00970	0.00446	0.00579	0.00567	0.00493	0.00648	0.00649
40	0.30	0.00595	0.00485	0.00540	0.00469	0.00504	0.00651	0.00613	0.00473	0.00538	0.00454	0.00558	0.00680
	0.50	0.00584	0.00679	0.00672	0.00591	0.00750	0.00774	0.00518	0.00612	0.00471	0.00726	0.00769	0.00777
	0.70	0.00475	0.00571	0.00481	0.00576	0.00545	0.00879	0.00586	0.00505	0.00437	0.00517	0.00588	0.00677
	0.75	0.00516	0.00445	0.00476	0.00524	0.00484	0.00722	0.00379	0.00507	0.00367	0.00564	0.00486	0.00434
	0.80	0.00323	0.00539	0.00386	0.00399	0.00316	0.00686	0.00374	0.00438	0.00396	0.00327	0.00411	0.00521
120	0.30	0.00195	0.00159	0.00169	0.00181	0.00196	0.00185	0.00189	0.00175	0.00174	0.00144	0.00202	0.00195
	0.50	0.00208	0.00244	0.00199	0.00202	0.00237	0.00195	0.00167	0.00179	0.00216	0.00167	0.00208	0.00245
	0.70	0.00218	0.00186	0.00148	0.00214	0.00164	0.00212	0.00168	0.00187	0.00212	0.00168	0.00168	0.00172
	0.75	0.00140	0.00156	0.00190	0.00179	0.00151	0.00254	0.00170	0.00177	0.00147	0.00165	0.00174	0.00245
	0.80	0.00130	0.00159	0.00168	0.00130	0.00139	0.00225	0.00134	0.00104	0.00111	0.00145	0.00131	0.00158

BEST COPY AVAILABLE

Table 10.7c

Mean Squared Errors of the Estimates of h from the Goodman Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant z_t's			Varied z_t's			Constant z_t's			Varied z_t's		
		.20	.40	.50	.10 to .65	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.01003	0.00912	0.00830	0.01275	0.01169	0.01136	0.01073	0.01290	0.01076	0.01068	0.01101	0.01019
	0.50	0.01215	0.01250	0.01303	0.01081	0.01199	0.01278	0.01351	0.01326	0.01346	0.01245	0.01078	0.01176
	0.70	0.00909	0.01187	0.01105	0.01046	0.01121	0.01185	0.00907	0.01146	0.01169	0.01083	0.00967	0.01008
	0.75	0.00864	0.00642	0.00862	0.00912	0.00975	0.01254	0.00904	0.00833	0.00934	0.00846	0.00758	0.00745
	0.80	0.00720	0.00803	0.00944	0.00790	0.00881	0.00863	0.00763	0.00833	0.00886	0.00823	0.00912	0.00869
30	0.30	0.00578	0.00768	0.00755	0.00609	0.00530	0.00631	0.00759	0.01045	0.00762	0.00605	0.00715	0.00604
	0.50	0.00916	0.01143	0.01151	0.00810	0.00749	0.00820	0.00799	0.00798	0.00888	0.01021	0.00879	0.00951
	0.70	0.00714	0.00722	0.00820	0.00723	0.00582	0.00910	0.00840	0.00676	0.00652	0.00753	0.00657	0.00800
	0.75	0.00699	0.00563	0.00708	0.00796	0.00668	0.00606	0.00582	0.00634	0.00600	0.00538	0.00807	0.00579
	0.80	0.00485	0.00513	0.00398	0.00383	0.00544	0.00609	0.00444	0.00563	0.00561	0.00476	0.00648	0.00533
40	0.30	0.00585	0.00481	0.00529	0.00468	0.00509	0.00584	0.00613	0.00468	0.00533	0.00462	0.00551	0.00583
	0.50	0.00583	0.00673	0.00628	0.00597	0.00751	0.00692	0.00513	0.00607	0.00480	[illegible]	0.00765	0.00647
	0.70	0.00479	0.00532	0.00429	0.00566	0.00552	0.00761	0.00580	0.00497	0.00460	[illegible]	0.00581	0.00562
	0.75	0.00508	0.00408	0.00458	0.00510	0.00478	0.00533	0.00379	0.00471	0.00344	0.00548	0.00486	0.00404
	0.80	0.00324	0.00493	0.00349	0.00407	0.00313	0.00395	0.00376	0.00434	[illegible]	0.00333	0.00411	0.00359
120	0.30	0.00196	0.00164	0.00163	0.00183	0.00199	0.00150	0.00189	0.00174	[illegible]	0.00142	0.00202	0.00189
	0.50	0.00208	0.00235	0.00179	0.00202	0.00237	0.00157	0.00166	0.00181	0.00216	0.00169	0.00206	0.00208
	0.70	0.00219	0.00174	0.00136	0.00206	0.00164	0.00195	0.00165	[illegible]	0.00201	0.00159	0.00168	0.00147
	0.75	0.00141	0.00136	0.00171	0.00175	0.00149	0.00190	0.00170	0.00178	0.00142	0.00161	0.00175	0.00207
	0.80	0.00129	0.00153	0.00155	0.00124	0.00141	0.00180	0.00132	0.00105	0.00110	0.00142	0.00130	0.00127

BEST COPY AVAILABLE

Table 10.7d.

Mean Squared Errors of the Estimates of b from the Newton-Raphson Procedure for Each Combination

n	b	m=10 items						m=15 items					
		Constant s_t's			Varied s_t's			Constant s_t's			Varied s_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.01003	0.00911	0.00832	0.01275	0.01169	0.01684	0.01073	0.01290	0.01076	0.01068	0.01101	0.01143
	0.50	0.01215	0.01251	0.01303	0.01081	0.01200	0.02949	0.01351	0.01326	0.01346	0.01245	0.01078	0.01200
	0.70	0.00909	0.01187	0.01106	0.01045	0.01121	0.02082	0.00907	0.01146	0.01169	0.01083	0.00967	0.00986
	0.75	0.00864	0.00642	0.00862	0.00912	0.00975	0.02888	0.00904	0.00833	0.00934	0.00846	0.00758	0.00764
	0.80	0.00720	0.00803	0.00944	0.00791	0.00881	0.01717	0.00763	0.00833	0.00886	0.00823	0.00912	0.00875
30	0.30	0.00578	0.00768	0.00756	0.00609	0.00530	0.01430	0.00759	0.01045	0.00762	0.00605	0.00715	0.00704
	0.50	0.00916	0.01143	0.01151	0.00811	0.00749	0.00971	0.00799	0.00798	0.00888	0.01021	0.00879	0.00886
	0.70	0.00714	0.00722	0.00820	0.00723	0.00582	0.01437	0.00840	0.00676	0.00652	0.00753	0.00657	0.00814
	0.75	0.00699	0.00563	0.00708	0.00796	0.00668	0.01303	0.00582	0.00634	0.00600	0.00538	0.00807	0.00603
	0.80	0.00485	0.00513	0.00398	0.00383	0.00544	0.01555	0.00444	0.00565	0.00561	0.00476	0.00648	0.00540
40	0.30	0.00585	0.00481	0.00529	0.00468	0.00509	0.01351	0.00613	0.00468	0.00533	0.00462	0.00551	0.00569
	0.50	0.00583	0.00673	0.00628	0.00597	0.00751	0.00718	0.00513	0.00607	0.00480	0.00721	0.00765	0.00643
	0.70	0.00479	0.00532	0.00429	0.00566	0.00552	0.01249	0.00580	0.00497	0.00460	0.00499	0.00581	0.00565
	0.75	0.00508	0.00408	0.00458	0.00510	0.00478	0.01230	0.00379	0.00471	0.00344	0.00548	0.00486	0.00396
	0.80	0.00324	0.00493	0.00349	0.00407	0.00313	0.00528	0.00376	0.00434	0.00361	0.00333	0.00411	0.00361
120	0.30	0.00196	0.00164	0.00163	0.00183	0.00199	0.00153	0.00189	0.00174	0.00172	0.00142	0.00202	0.00188
	0.50	0.00208	0.00235	0.00179	0.00202	0.00237	0.00167	0.00166	0.00181	0.00216	0.00169	0.00206	0.00208
	0.70	0.00219	0.00174	0.00136	0.00206	0.00164	0.00195	0.00165	0.00184	0.00201	0.00159	0.00168	0.00147
	0.75	0.00141	0.00156	0.00171	0.00175	0.00149	0.00190	0.00170	0.00178	0.00142	0.00161	0.00175	0.00207
	0.80	0.00129	0.00153	0.00155	0.00124	0.00141	0.00180	0.00132	0.00105	0.00110	0.00142	0.00130	0.00127

BEST COPY AVAILABLE

Table 10 8

Frequency Distributions of the Mean Squared Errors of the Estimates of b Across All Combinations

Mid-points of the Intervals	Estimation Procedures			
	Spearman	Minres	Goodman	N - R.
.001	13	12	15	15
.002	46	47	45	45
.003	4	4	5	5
.004	14	14	14	13
.005	28	28	30	30
.006	25	25	32	27
.007	22	22	16	16
.008	22	22	26	25
.009	21	19	18	17
.010	10	8	9	8
.011	11	15	12	12
.012	10	10	9	10
.013	9	10	8	7
.014	4	2	1	4
.015	0	1		0
.016	1	0		1
.017		0		2
.018		0		0
.019		1		0
.020				0
.021				1
.022				
.023				
.024				
.025				
.026				
.027				
.028				
.029				2
Total	240	240	240	240

BEST COPY AVAILABLE

each combination were in close agreement among the four procedures. The greatest discrepancies occurred between the Newton-Raphson procedure and the others when the x_t's were restricted to be at least 0.50 for the 10-item test with n = 20. It coincided with our earlier discovery that a number of the replications failed to converge under this restriction. The MSE's for each combination could be decomposed into two parts: the variance of the estimates and the squared average deviations of the estimates from the parameter k. The differences between the MSE's and the variances for each combination were simply the squared average deviations of the estimates from the parameter k. The frequency distributions of these squared average deviations (SAD's) are summarized in Table 10.9. The majority of these SAD's were very small, with only 11 of the 240 × 4 cases greater than 0.0005 for all procedures. The extreme ones, however, occurred when the x_t's were restricted to be at least 0.50 for the 10-item test with n = 20. The magnitudes of these SAD's suggested that the restriction on x_t's had produced poorer estimates. The discrepancies of the MSE's between the estimates from the Newton-Raphson procedure and from the others also suggested that the variances of the estimates were greater under these combinations. This might have been influenced by the larger number of failures to converge for this procedure. In contrast, the Goodman procedure seemed the least affected by the choices of x_t's. The MSE's for the Goodman procedure were more stable across the different choices of x_t's.

The differences between the MSE's and the variances could also be used as an indicator of possible biases of the estimators of k. For unbiased estimators, the variance of the estimates is also the MSE of the estimates. As we have shown previously, the majority of the SAD's were less than 0.0005. This was misleading, however, since the MSE's of the estimates were also small. Thus it was proposed to use the percent differences between the MSE's and the variances in MSE's, i.e., $[(\text{MSE-variance})/\text{MSE}] \times 100$, as an index. The frequency distributions of this index for the four procedures are summarized in Table 10.10. The average percent differences were respectively 1.001%, 0.974%, 0.947% and 1.001%, for the Spearman, Minres, Goodman and Newton-Raphson procedures. Ninety per cent of the percent differences were less than 3%. If sampling variation is taken into consideration, given that these estimators are biased, the biases are of small magnitudes. Note also, the MSE's and the variances seemed to be a quadratic function of k but an inverse function of n. That is, the MSE's increased as k approached 0.50 and decreased as n increased. This is evidenced by the correlations between estimates of the variances calculated using the binomial formula, i.e.,

$$\widehat{\mathrm{var}}(\hat{k}) = \frac{\bar{\hat{k}}(1 - \bar{\hat{k}})}{n - 1},$$

where $\bar{\hat{k}}$ was the average estimate of k for each combination. The correlations between $\mathrm{var}(\hat{k})$ and the variances and MSE's ranged from 0.83190 and 0.96646 over all the combinations. (See Table 10.11.) The correlations were lower, however, for the MSE's. As shown in Table 10.12, the $\widehat{\mathrm{var}}(k)$ --the actual parametric values of k were used here--approximated the MSE's and the variances quite well. The MSE's and variances were averaged over the different sets of x_t's and test length.

Table 10.9

Frequency Distributions of the Differences Between the Mean Squared Errors and the Variances of the Estimates of h Across All Combinations

Mid-points of the Intervals (MSE-Var)	Estimation Procedures			
	Spearman	Minres	Goodman	N - A
.0000	167	153	168	168
.0001	44	57	48	44
.0002	14	13	11	12
.0003	6	4	6	4
.0004	3	6	4	6
.0005	1	3	2	2
.0006	1		1	2
.0007		1		
.0008		1		
.0009		1		1
.0010				
.0011	1			
.0012				
.0013				
.				
.				
.0025				1
.				
.				
.0030		1		
Total	240	240	240	240

BEST COPY AVAILABLE

Table 10.10

Frequency Distributions of the Percent Differences Between the Mean Squared Errors and the Variances of the Estimates of b Across All Combinations

$$\left(\frac{\text{MSE} - \text{Var}}{\text{MSE}} \times 100 \right)$$

Mid-points of the Intervals	Estimation Procedures			
	Spearman	Minres	Goodman	N. - R.
0.0%	45	49	43	41
0.1%	31	19	27	35
0.2%	14	15	23	21
0.3%	10	16	15	16
0.4%	12	11	13	12
0.5%	9	8	7	8
0.6%	14	12	12	9
0.7%	11	9	8	7
0.8%	11	9	9	9
0.9%	7	3	12	10
1.0%	11	8	2	3
1.0 - 1.9%	31	41	40	35
2.0 - 2.9%	15	17	9	11
3.0 - 3.9%	6	8	8	9
4.0 - 4.9%	6	8	8	8
5.0 - 5.9%	4	3	2	2
6.0 - 6.9%	2	3	1	2
over 7%		1	1	2
Total	240	240	240	240

BEST COPY AVAILABLE

Table 10.11

Correlations of the Estimated Variances With the Observed Variances and the Mean Squared Errors Across All Combinations

(Number of Cases in Parathenses)

	Estimation Procedures			
	Spearman	Minres	Goodman	Newton-Raphson
Mean Squared Errors	.94120 (240)	.93932 (240)	.96578 (240)	.83190 (240)
Observed Variance	.94385 (240)	.94497 (240)	.96646 (240)	.83993 (240)

Table 10.12

The Estimated Variances, the Average Observed Variances, and the Average Mean Squared Errors of the Estimates of k by h and Sample Size (n)

			Estimation Procedures							
		Estimated	Spearman		Minres		Goodman		Newton-Raphson	
n	h	var	MSE	var	MSE	var	MSE	var	MSE	var
	0.30	0.0110526	0.0111214	0.0110149	0.0110873	0.0109028	0.0107939	0.0106806	0.0113535	0.0111949
	0.50	0.0131579	0.0125332	0.0124134	0.0125526	0.0124076	0.0123735	0.0122565	0.0137858	0.0135929
20	0.70	0.0110526	0.0113287	0.0112122	0.0113883	0.0112390	0.0106952	0.0105884	0.0114242	0.0113362
	0.75	0.0098684	0.0094211	0.0092892	0.0097652	0.0094360	0.0087733	0.0086788	0.0101514	0.0098989
	0.80	0.0084211	0.0090456	0.0089312	0.0090732	0.0090153	0.0084063	0.0083549	0.0091235	0.0090674
	0.30	0.0072414	0.0071526	0.0071197	0.0072352	0.0071673	0.0069667	0.0069327	0.0077172	0.0076632
	0.50	0.0086207	0.0093238	0.0092455	0.0094556	0.0093148	0.0091033	0.0090244	0.0091761	0.0091029
30	0.70	0.0072414	0.0078977	0.0077965	0.0077961	0.0077185	0.0073727	0.0072869	0.0078233	0.0077283
	0.75	0.0064655	0.0067330	0.0066386	0.0067024	0.0066346	0.0064829	0.0063971	0.0070846	0.0069872
	0.80	0.0055172	0.0055861	0.0055086	0.0055936	0.0055385	0.0051322	0.0050794	0.0059265	0.0058686
	0.30	0.0053846	0.0053839	0.0053260	0.0054663	0.0053971	0.0053054	0.0052407	0.0059320	0.0058267
	0.50	0.0064103	0.0066065	0.0065430	0.0066021	0.0065312	0.0063803	0.0063200	0.0063991	0.0063240
40	0.70	0.0053846	0.0057782	0.0056904	0.0056970	0.0056342	0.0054155	0.0053458	0.0058248	0.0057583
	0.75	0.0048077	0.0049860	0.0049495	0.0049213	0.0048719	0.0046066	0.0045748	0.0051801	0.0051516
	0.80	0.0041026	0.0042194	[illegible]1814	0.0042645	0.0042012	0.0037956	0.0037537	0.0039075	0.0038690
	0.30	0.0017647	0.0018025	0.0017798	0.0018033	0.0017750	0.0017679	0.0017460	0.0017689	0.0017487
	0.50	0.0021008	0.0020305	0.0020201	0.0020560	0.0020440	0.0019712	0.0019624	0.0019797	0.0019708
120	0.70	0.0017647	0.0018559	0.0018414	0.0018480	0.0018322	0.0017641	0.0017505	0.0017640	0.0017505
	0.75	0.0015756	0.0017720	0.0017642	0.0017894	0.0017741	0.0016801	0.0016708	0.0016803	0.0016710
	0.80	0.0013445	0.0014580	0.0014454	0.0014454	0.0014342	0.0013571	0.0013388	0.0013571	0.0013388

Over all combinations of k, m, n, and x_t's, the mean average deviations (AD's) of the estimates from k, were 0.001121, -0.001784, 0.000502 and 0.0003233, for the Spearman, Minres, Goodman and Newton-Raphson procedures, respectively. The AD's for each combination are summarized in Tables 10.13 a-d for the four procedures. As shown in Table 10.14, the frequency distributions of the AD's were within the intervals with midpoint -0.053 and 0.026 for all four procedures, with the Goodman procedure having the narrowest range (from -0.023 to 0.021). Note also that 95% of these AD's were within the range -0.019 and 0.017. To discover the influences of the other parameters used in this study on these estimates of k, the analyses of variance (ANOVA) on the estimates was used. There were four completely crossed factors and one nested factor: the choice of k (with 5 levels), the sample size n (wtih 4 levels), the test length m (with two levels), and the characteristics of the choices of x_t's (with two levels: constant vs. varied), with the 12 sets of x_t's nested within test length and the characteristics of the x_t's. However, as mentioned above, there was evidence that the means and the variances for each combination were related. Thus, the ANOVA's were performed using the arcsine transformation on $\hat{k}$, i.e., $2\sin^{-1}\hat{k}^{1/2}$. The ANOVA's are summarized in Table 10.15 for the four procedures. A significance level of 0.05 was used while the actual probability levels were also reported.

The main effect of k was significant at the 0.0001 level for all four procedures. This was not surprising since k was the parameter being estimated. The main effect of the sample size, n, was significant for the two maximum likelihood estimation procedures, i.e., the Goodman and Newton-Raphson procedures. As sample size increased, as shown in Table 10.16, the AD's tended to be closer to zero. The interaction between k and n was significant for the procedures, however. While the length of the test was not significant for any of the four procedures, the effects related to the choices of x_t's were significant for the Minres and Newton-Raphson procedures. For the Minres procedure, only the nesting factor for the different choices of x_t's was significant. This was consistent with the indication that the SSR's were affected by the choices of x_t's. For the Newton-Raphson procedure, the main effect due to the characteristics of the x_t's was significant. The interaction between this factor and n, and the four-way interaction between k, n, m and this factor was also significant. Finally, the interactions between the nested factor and k, and between the nested factor, k and n were also significant. The ANOVA's revealed some expected and unexpected results. While we expected that k would be a significant factor, it was encouraging to confirm that larger sample size would lead to better estimates. This conformed to the notion that the maximum likelihood estimator for the latent class model in general was consistent. This was also borne out by the empirical relationship found between the MSE's and the variances of the estimates with the sample size. However, the findings that the estimates from the Minres and Newton-Raphson procedures were related to the choices of x_t's made these two procedures less appealing. The comparisons discussed thus far indicated that the Goodman procedure was more satisfactory overall. Although failures of convergence occurred in extreme situations, this procedure required a fewer number of trials to converge. As from theoretical observations, the Goodman procedure produced consistent estimates for k. And more importantly, the estimates were less affected by the choice of x_t's.

Table 10.13a

Average Deviations of the Estimates of b from the Spearman Procedure for Each Combination

n	b	m=10 items						m=15 items					
		Constant π_t's			Varied π_t's			Constant π_t's			Varied π_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
	0.30	-.00136	-.00581	0.00224	0.02117	-.00747	-.00163	0.00555	-.00953	-.02400	-.00395	0.00108	-.00196
	0.50	-.00535	0.01258	0.00229	0.01451	0.01023	0.01175	0.01441	0.00247	-.02134	0.00567	0.00866	-.00169
20	0.70	0.00208	-.00824	-.00161	0.00261	0.02189	0.01794	-.01089	-.00396	0.00969	0.00241	-.00562	-.01535
	0.75	0.01035	0.00913	0.00715	0.00482	0.00159	-.03240	-.00395	0.00842	-.01198	0.00272	0.00170	-.00326
	0.80	-.00191	0.01547	0.00212	-.00232	0.00901	0.02588	0.01018	-.00269	0.01402	0.00681	-.00085	-.00075
	0.30	0.00435	-.00680	-.00585	-.00426	-.00691	0.00071	-.00051	0.01017	-.00289	0.00824	-.00456	-.00498
	0.50	-.00353	-.01829	0.00063	-.00837	-.00846	-.00770	-.00458	0.00305	-.00599	0.01084	0.01069	-.00918
30	0.70	-.00759	-.00646	-.00396	-.00277	-.00362	0.01129	-.01998	-.00664	-.00202	0.00608	0.00733	0.02003
	0.75	0.00086	0.01604	-.00499	0.00696	0.00681	0.00813	0.00180	-.01599	0.00384	0.00347	0.00094	0.01979
	0.80	-.00618	-.00273	0.00587	0.01532	-.00970	0.01194	-.01256	0.00085	-.00342	0.00674	-.00074	0.01234
	0.30	0.00151	0.01390	-.00551	-.00116	0.00786	-.00630	-.01004	0.00013	0.01297	0.00407	0.00857	-.00039
	0.50	-.00946	0.00235	0.01305	0.00534	0.01446	0.00406	-.00714	-.00466	0.01137	0.00057	0.00167	-.00544
40	0.70	0.00361	0.00362	-.00614	0.01615	-.00233	0.01417	0.01109	0.01713	0.00532	0.00544	0.00118	0.00602
	0.75	0.00163	-.00685	0.00131	0.00667	-.00422	0.00644	0.00241	0.00085	0.01121	-.00766	0.00630	-.00692
	0.80	0.00677	-.00602	0.00440	-.00218	0.00103	-.00847	0.00095	-.00870	-.01044	0.00757	0.00529	0.00096
	0.30	0.00003	0.00299	0.00475	0.00277	0.00590	-.00369	0.01084	0.00023	0.00420	0.00084	-.00580	-.00351
	0.50	-.00050	0.00111	-.00057	0.00039	-.00394	0.00409	0.00091	-.00686	0.00196	0.00346	0.00398	-.00316
120	0.70	0.00637	-.00460	0.00309	-.00159	-.00653	0.00482	0.00036	-.00141	0.00436	0.00130	-.00082	-.00301
	0.75	-.00373	0.00190	-.00034	0.00358	-.00166	-.00391	0.00056	0.00571	-.00220	0.00142	0.00149	-.00165
	0.80	0.00094	0.001[illegible]	-.00169	0.00072	0.00257	0.00838	0.00228	-.00526	0.00209	-.00467	-.00275	0.00027

Table 10.13b

Average Deviations of the Estimates of b from the Minres Procedure for Each Combination

n	b	m=10 items						m=15 items					
		Constant a_t's			Varied a_t's			Constant a_t's			Varied a_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	-.00174	-.00826	-.00311	0.01945	-.00820	-.02278	0.00526	-.01150	-.02733	-.00395	0.00074	-.01427
	0.50	-.00576	0.00835	-.00471	0.01143	0.00969	-.00760	0.01409	0.00013	-.02539	0.00437	0.00815	-.01964
	0.70	0.00158	-.01159	-.01024	0.00086	0.02123	-.00409	-.01139	-.00628	0.00349	0.00128	-.00603	-.02907
	0.75	0.00992	0.00555	0.00107	0.00467	0.00093	-.05409	-.00430	0.00644	-.01688	0.00129	0.00129	-.02201
	0.80	-.00215	0.01097	-.00522	-.00259	0.00857	0.00238	0.00979	-.00529	0.00864	0.00544	-.00180	-.01475
30	0.30	0.00404	-.00918	-.00948	-.00505	-.00736	-.01192	-.00077	0.00912	-.00601	0.00679	-.00490	-.01433
	0.50	-.00382	-.01983	-.00444	-.00912	-.00896	-.01939	-.00485	0.00154	-.00976	0.00920	0.01040	-.01979
	0.70	-.00781	-.00861	-.00960	-.00498	-.00414	0.00203	-.02035	-.00877	-.00541	0.00459	0.00681	0.00777
	0.75	0.00049	0.01449	-.00884	0.00697	0.00612	-.00463	0.00161	-.01801	0.00012	0.00311	0.00016	0.00852
	0.80	-.00636	-.00593	0.00139	0.01398	-.01013	-.00231	-.01270	-.00091	-.00759	0.00562	-.00123	-.00425
40	0.30	0.00124	0.01206	-.00931	-.00210	0.00768	-.01291	-.01030	-.00120	0.01092	0.00318	0.00834	-.00715
	0.50	-.00979	0.00067	0.01006	0.00472	0.01420	-.00637	-.00736	-.00598	0.00800	-.00050	0.00144	-.01498
	0.70	0.00335	0.00135	-.00868	0.01563	-.00304	-.00116	0.01089	0.01584	0.00250	0.00500	0.00094	0.00065
	0.75	0.00134	-.00807	-.00233	0.00592	-.00440	-.00470	0.00225	-.00048	0.00896	-.00861	0.00602	-.01555
	0.80	0.00659	-.00806	0.00086	-.00235	0.00039	-.01698	0.00075	-.01004	-.01247	0.00575	0.00490	-.00583
120	0.30	-.00004	0.00213	0.00363	0.00276	0.00580	-.00863	0.01080	-.00015	0.00330	0.00078	-.00590	-.00635
	0.50	-.00062	0.00061	-.00157	-.00021	-.00407	0.00120	0.00084	-.00730	0.00104	0.00348	0.00392	-.00619
	0.70	0.00627	-.00546	0.00203	-.00189	-.00666	0.00199	0.00031	-.00186	0.00340	0.00090	-.00087	-.00677
	0.75	-.00382	0.00123	-.00172	0.00325	-.00182	-.00847	0.00049	0.00525	-.00303	0.00121	0.00149	-.00603
	0.80	0.00081	0.00058	-.00299	0.00063	0.00232	0.00641	0.00221	-.00561	0.00121	-.00504	-.00280	-.00251

Table 10.13c

Average Deviations of the Estimates of h from the Goodman Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant s_t's			Varied s_t's			Constant s_t's			Varied s_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .75
	0.30	-.00150	-.00747	0.00334	0.02051	-.00750	-.00584	0.00550	-.01050	-.02299	-.00450	0.00100	-.00866
	0.50	-.00450	0.01355	0.00518	0.01402	0.01050	0.00445	0.01450	0.00250	-.02249	0.00450	0.00850	-.00420
20	0.70	0.00200	-.00993	-.00734	0.00101	0.02100	0.01718	-.01150	-.00400	0.00752	0.00350	-.00550	-.01132
	0.75	0.01000	0.01009	0.00528	0.00551	0.00200	-.02372	-.00400	0.00700	-.01398	0.00450	0.00100	-.00373
	0.80	-.00150	0.01309	-.00374	-.00248	0.00850	0.00864	0.01000	-.00100	0.00952	0.00800	-.00150	-.00343
	0.30	0.00433	-.00663	-.00438	-.00366	-.00600	-.00351	-.00067	0.00967	-.00299	0.00700	-.00433	-.00943
	0.50	-.00267	-.01994	0.00013	-.00799	-.00900	-.00678	-.00467	0.00233	-.00565	0.01000	0.01100	-.00788
30	0.70	-.00800	-.00559	-.00599	-.00532	-.00300	0.00673	-.02000	-.00867	-.00231	0.00500	0.00700	0.01585
	0.75	0.00100	0.01641	-.00658	0.00835	0.00600	-.00066	0.00133	-.01733	0.00236	0.00367	0.00033	0.01667
	0.80	-.00533	-.00291	0.00280	0.01502	-.00833	-.00038	-.01200	0.00033	-.00331	0.00600	-.00100	0.00978
	0.30	0.00100	0.01403	-.00595	-.00174	0.00900	-.00968	-.01025	-.00025	0.01276	0.00350	0.00875	-.00097
	0.50	-.00975	0.00204	0.01101	0.00626	0.01450	-.00043	-.00750	-.00450	0.01176	0.00050	0.00175	-.00530
40	0.70	0.00300	0.00357	-.00409	0.01527	-.00275	0.00687	0.01050	0.01700	0.00827	0.00550	0.00125	0.00152
	0.75	0.00100	-.00592	0.00196	0.00451	-.00425	0.00442	0.00225	0.00100	0.00927	-.00900	0.00650	-.00804
	0.80	0.00775	-.00667	0.00527	-.00148	0.00000	-.00563	0.00100	-.01050	-.01097	0.00625	0.00525	-.00574
	0.30	-.00000	0.00262	0.00413	0.00317	0.00583	-.004[illegible]0	0.01067	0.00000	0.00468	0.00100	-.00558	-.00200
	0.50	-.00058	0.00055	0.00032	0.00043	-.00383	0.000[illegible]2	0.00092	-.00683	0.00110	0.00433	0.00367	-.00268
120	0.70	0.00642	-.00492	0.00418	-.00140	-.00625	0.002[illegible]2	0.00017	-.00158	0.00427	0.00117	-.00108	-.00285
	0.75	-.00358	0.00150	-.00163	0.00318	-.00167	-.0053[illegible]	-.00000	0.00600	-.00181	0.00075	0.00192	-.00284
	0.80	0.00058	-.00001	-.00163	0.00127	0.00267	0.01[illegible]26	0.00225	-.00400	0.00236	-.00467	-.00217	0.00132

Table 10.13d

Average Deviations of the Estimates of b from the Newton-Raphson Procedure for Each Combination

n	b	m=10 items						m=15 items					
		Corstant s_t's			Varied s_t's			Constant s_t's			Varied s_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	-.00150	-.00749	0.00328	0.02046	-.00750	-.02514	0.00550	-.01050	-.02299	-.00450	0.00100	0.00337
	0.50	-.00450	0.01354	0.00518	0.01394	0.01049	-.03039	0.01450	0.00250	-.02248	0.00450	0.00850	0.00357
	0.70	0.00200	-.00993	-.00735	0.00098	0.02100	0.00840	-.01150	-.00400	0.00752	0.00350	-.00550	-.01135
	0.75	0.01000	0.01009	0.00528	0.00547	0.00200	-.04942	-.00400	0.00700	-.01398	0.00450	0.00100	-.00088
	0.80	-.00150	0.01309	-.00374	-.00251	0.00850	0.01172	0.01000	-.00100	0.00952	0.00800	-.00150	0.00227
30	0.30	0.00433	-.00663	-.00438	-.00370	-.00600	-.01735	-.00067	0.00967	-.00299	0.00700	-.00433	-.00599
	0.50	-.00267	-.01994	0.00013	-.00802	-.00900	0.00541	-.00467	0.00233	-.00565	0.01000	0.01100	-.00305
	0.70	-.00800	-.00559	-.00599	-.00535	-.00300	-.00010	-.02000	-.00867	-.00231	0.00500	0.00700	0.02016
	0.75	0.00100	0.01641	-.00658	0.00834	0.00600	-.00678	0.00133	-.01733	0.00236	0.00367	0.00033	0.01926
	0.80	-.00533	-.00291	0.00280	0.01501	-.00834	0.00400	-.01200	0.00033	-.00331	0.00600	-.00100	0.01184
40	0.30	0.00100	0.01403	-.00595	-.00177	0.00900	-.02382	-.01025	-.00025	0.01276	0.00350	0.00875	0.00267
	0.50	-.00975	0.00205	0.01101	0.00625	0.01450	0.01389	-.00750	-.00450	0.01176	0.00050	0.00175	-.00330
	0.70	0.00300	0.00357	-.00409	0.01526	-.00275	-.00002	0.01050	0.01700	0.00827	0.00550	0.00125	0.00336
	0.75	0.00100	-.00592	0.00196	0.00451	-.00425	-.00267	0.00225	0.00100	0.00927	-.00900	0.00650	-.00615
	0.80	0.00775	-.00667	0.00527	-.00148	-.00000	0.00060	0.00100	-.01050	-.01097	0.00625	0.00525	-.00496
120	0.30	-.00000	0.00262	0.00413	0.00317	0.00583	-.00138	0.01067	0.00000	0.00468	0.00100	-.00558	-.00156
	0.50	-.00058	0.00055	0.00032	0.00043	-.00383	0.00181	0.00092	-.00683	0.00110	0.00433	0.00367	-.00253
	0.70	0.00642	-.00492	0.00418	-.00140	-.00625	0.00242	0.00017	-.00158	0.00427	0.00117	-.00108	-.00271
	0.75	-.00358	0.00150	-.00163	0.00318	-.00167	-.00535	-.00000	0.00600	-.00181	0.00075	0.00192	-.00281
	0.80	0.00058	-.00001	-.00163	0.00127	0.00267	0.01226	0.00225	-.00400	0.00236	-.00467	-.00217	0.00132

Table 10.14

Frequency Distributions of the Average Deviations of the Estimates of h Across All Combinations

Midpoint of the Intervals	Estimation Procedures			
	Spearman	Minres	Goudman	N. - R.
-.030 or less	1	1	0	1
-.020 to -.029	2	5	3	5
-.010 to -.019	7	20	8	9
-.009	4	7	6	5
-.008	3	11	5	3
-.007	7	8	6	5
-.006	9	7	8	7
-.005	11	14	12	11
-.004	10	12	8	9
-.003	13	9	17	12
-.002	9	7	10	13
-.001	14	12	11	11
.000	18	19	26	25
.001	23	30	21	21
.002	18	12	13	14
.003	9	9	8	13
.004	12	4	12	12
.005	7	8	9	9
.006	10	10	11	10
.007	8	4	5	3
.008	6	6	6	8
.009	4	6	5	3
.010 to 0.019	30	15	28	29
.020 to 0.029	5	1	2	3
.030 or more				
Total	240	240	240	240

Table 10.13

Analyses of Variance of the Arcsine Transformation
of the Estimates of k from the Four Estimation Procedures

Sources*	degree of freedom	Estimation Procedures							
		Spearman		Minres		Goodman		Newton-Raphson	
		sum of squares	Pr>F	sum of squares	Pr>F	sum of squares	Pr>F	sum of squares	Pr>F
K	4	3772.5856	0.0001	3755.1171	0.0001	3769.0636	0.0001	3693.2018	0.0001
M	1	0.0360	0.2929	0.0091	0.5961	0.0183	0.4433	0.0214	0.4292
KxM	4	0.1530	0.9763	0.0069	0.9947	0.0154	0.9745	0.0336	0.9128
N	3	0.1905	0.1170	0.0809	0.4768	0.2641	0.0368	0.2988	0.0327
KxN	12	1.2415	0.0001	1.0751	0.0009	1.2968	0.0001	1.2146	0.0004
MxN	3	0.2104	0.0893	0.1680	0.1555	0.2120	0.0775	0.0734	0.5467
KxMxN	12	0.2699	0.7612	0.2481	0.8089	0.2308	0.8305	0.3285	0.6515
XS	1	0.1552	0.0289	0.0021	0.8004	0.0839	0.1010	0.4244	0.0004
KxXS	4	0.1336	0.3914	0.1262	0.4183	0.1111	0.4691	0.0000	1.0000
MxXS	1	0.0008	0.8779	0.0001	0.9474	0.0026	0.7749	0.0038	0.7404
KxMxXS	4	0.0715	0.6995	0.0538	0.7966	0.0690	0.6973	0.1600	0.3230
NxXS	3	0.2482	0.0533	0.1719	0.1475	0.1734	0.1335	0.4167	0.0070
KxNxXS	12	0.4090	0.4005	0.3982	0.4188	0.3589	0.4869	0.1496	0.9759
MxNxXS	3	0.1126	0.3258	0.0940	0.4065	0.1400	0.2120	0.1112	0.3555
KxMxNxXS	12	0.6416	0.0724	0.5609	0.1358	0.5586	0.1190	0.7333	0.0447
XG (within MxXS)	8	0.0749	0.9703	1.5816	0.0001	0.2084	0.5720	0.1657	0.7748
KxXG (within MxXS)	32	0.7771	0.8479	0.7860	0.8310	0.6296	0.9481	1.7012	0.0241
NxXG (within MxXS)	24	0.5534	0.8478	1.0084	0.1468	0.5005	0.8867	0.9965	0.2166
KxNxXG (within MxXS)	96	3.3943	0.2627	3.3922	0.2465	3.2268	0.2867	4.1186	0.0480
Error (d.f. for Error)		771.9237	(23739)	765.5659	(23727)	740.9332	(23738)	798.7128	(23322)
Total (d.f. for Total)		4553.0449	(23978)	4530.4462	(23966)	4518.0970	(23977)	4502.6784	(23561)

*The Five Factors Are:
K = The Parametric Values of k (5 Levels);
M = The Test Length (2 Levels);
N = Number of Students (4 Levels);
XS = Characteristics of the Set of x's (2 Levels); and,
XG = The Sets of x's Nested Within M by XS (12 Groups).

Table 10.16

Mean Average Deviations of the Estimates of k
by k and Sample Size (n)

n	k	Estimation Procedures			
		Spearman	Minres	Goodman	N. - R.
	0.30	-0.0021391	-0.0064728	-0.0032180	-0.0038344
	0.50	0.0045152	-0.0005735	0.0038761	0.0016121
20	0.70	0.0009132	-0.0041884	0.0002191	-0.0005190
	0.75	-0.0004752	-0.0055098	-0.0000037	-0.0019116
	0.80	0.0062485	0.0011657	0.0036757	0.0044030
	0.30	-0.0011076	-0.0040875	-0.0017172	-0.0025872
	0.50	-0.0034072	-0.0065691	-0.0034255	-0.0020107
30	0.70	-0.0006927	-0.0040391	-0.0020241	-0.0022376
	0.75	0.0039696	0.0008426	0.0026285	0.0023334
	0.80	0.0014776	-0.0025514	0.0000553	0.0005909
	0.30	0.0021338	0.0000384	0.0016837	0.0008056
	0.50	0.0021812	-0.0004914	0.0016956	0.0030542
40	0.70	0.0062716	0.0036058	0.0054919	0.0050704
	0.75	0.0009296	-0.0016367	0.0003090	-0.0001245
	0.80	-0.0007303	-0.0030412	-0.0012897	-0.0007059
	0.30	0.0016297	0.0006766	0.0016597	0.0019640
	0.50	0.0000729	-0.0007391	-0.0001833	-0.0000543
120	0.70	0.0001953	-0.0007165	0.0000440	0.0000554
	0.75	0.0000966	-0.0009976	-0.0002941	-0.0002914
	0.80	0.0003391	-0.0003979	0.0008532	0.0008532

Estimates of x_t. The estimates of x_t were very similar among the four procedures. Since one-half of the combinations provided 10 different estimates of x_t's and the remaining provided 15 different estimates, there was a total of 3,000 possible estimates across all combinations, i.e., $120 \times 10 + 120 \times 15$. While our primary interest in the estimation procedures was their ability to estimate k, we summarized the estimates of x_t across all 3,000 possible combinations and presented the frequency distributions of the MSE's and AD's for these estimates only. The average MSE's and AD's for the estimates over the set of x_t's selected for each combination were also reported.

The frequency distributions for the MSE's for x_t's are presented in Table 10.17. The means for these distributions were 0.012567, 0.012416, 0.011800 and 0.011843, for the Spearman, Minres, Goodman and Newton-Raphson procedures. The majority of the MSE's were within intervals with mid-point less than .03. The percent difference between the MSE's and the variances were within 15% of the MSE's, while about 95% of them were less than 4%. The frequency distributions of the percent differences are summarized in Table 10.18. As shown in Tables 10.19 a-d, the average MSE's of each set of x_t's for each combination decreased when the sample size n and the parameter k increased. This was a persistent pattern for the twelve sets of x_t's and for all four estimation procedures. The average MSE's seemed to be less affected by the number of items in the test than by the average of the selected x_t's: the average MSE's seemed to increase with $\bar{x}$ when the x_t's were constant for all items and remained relatively constant when the x_t's were different for different items.

The AD's for x_t's over all combinations were 0.000790, -0.001358, 0.000021 and -0.000590, for the Spearman, Minres, Goodman and Newton-Raphson procedures, respectively. The frequency distributions for the AD's are summarized in Table 10.20. The AD's fell within the intervals with midpoint -0.08 and 0.06, while 90% of all cases were within -0.01 and 0.01 for all the procedures. The average AD's for the set of x_t's of each combination are reported in Tables 10.21 a-d for the four procedures. The average AD's tended to be closer to zero as n increased. No other pattern was obvious. In contrast to the estimates of k, the MSE's and AD's for the estimates of x_t's were wider in range. Over all the combinations, there were no noticeable differences between the four procedures. However, the estimates of x_t's did seem to do better when the sample size was large. This was both evident from the MSE's and AD's. At the same time, the average MSE's for the x_t's decreased as k increased. This could be explained by the fact that as k increased, the likelihood of selecting a student from the (+) category was greater, and consequently, it provided better estimates for the x_t's.

Table 10.17

Frequency Distributions of the Mean Squared Errors of the Estimates of x_t's Across All Combinations

Mid-points of the Intervals	Estimation Procedures			
	Spearman	Minres	Goodman	N. - R.
.00	781	796	814	807
.01	1336	1337	1388	1390
.02	571	566	524	528
.03	167	161	153	153
.04	61	58	58	56
.05	44	52	45	47
.06	31	24	14	13
.07	6	6	4	6
Total	3000	3000	3000	3000

Table 10.18

Frequency Distributions of the Percent Differences Between the Mean Squared Errors and the Variances of the Estimates of x_t's Across All Combinations

$$\left(\frac{MSE - VAR}{MSE} \times 100 \right)$$

Midpoint of the Intervals	Estimation Procedures			
	Spearman	Minres	Goodman	N. - R.
0 %	1590	1563	1592	1565
1 %	761	767	782	771
2 %	331	344	317	325
3 %	148	139	143	146
4 %	69	83	78	78
5 %	46	46	42	46
6 %	26	21	18	29
7 %	12	16	10	14
8 %	8	11	10	13
9 %	3	5	2	4
10 %	4	1	5	5
11 %	1	1		1
12 %		1		2
13 %	1	1		
14 %		1		
15 %			1	1
Total	3000	3000	3000	3000

Table 10.19a

Average Mean Squared Errors of the Estimates of x_t's from the Spearman Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant x_t's			Varied x_t's			Constant x_t's			Varied x_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
	0.30	0.03255	0.05167	0.05163	0.03992	0.04138	0.04728	0.03086	0.05328	0.05385	0.04398	0.03781	0.03950
	0.50	0.01790	0.02630	0.02953	0.01894	0.01957	0.02088	0.01729	0.02570	0.02940	0.02214	0.01992	0.02041
20	0.70	0.01146	0.01954	0.02214	0.01392	0.01368	0.01650	0.01311	0.01783	0.02058	0.01548	0.01365	0.01598
	0.75	0.01053	0.01712	0.01835	0.01233	0.01166	0.01637	0.01150	0.01684	0.01918	0.01444	0.01341	0.01495
	0.80	0.01024	0.01589	0.01708	0.01341	0.01185	0.01420	0.01067	0.01535	0.01632	0.01338	0.01272	0.01336
	0.30	0.01949	0.03613	0.03624	0.02206	0.02130	0.02865	0.02132	0.03356	0.03459	0.02383	0.02396	0.02709
	0.50	0.01128	0.01915	0.01919	0.01334	0.01343	0.01502	0.01152	0.01724	0.01792	0.01435	0.01344	0.01519
30	0.70	0.00876	0.01283	0.01333	0.00885	0.00880	0.01067	0.00825	0.01264	0.01296	0.01031	0.00872	0.00912
	0.75	0.00731	0.01102	0.01265	0.00827	0.00850	0.00952	0.00733	0.01215	0.01190	0.00967	0.00846	0.00947
	0.80	0.00706	0.01208	0.01104	0.00809	0.00805	0.00910	0.00697	0.01032	0.01154	0.00898	0.00819	0.00964
	0.30	0.01453	0.02084	0.02521	0.01746	0.01530	0.01887	0.01579	0.02346	0.02246	0.01858	0.01696	0.01891
	0.50	0.00862	0.01361	0.01504	0.00913	0.00935	0.01175	0.00795	0.01277	0.01434	0.01050	0.00923	0.01106
40	0.70	0.00595	0.00946	0.00991	0.00644	0.00662	0.00799	0.00581	0.00938	0.01008	0.00770	0.00731	0.00771
	0.75	0.00509	0.00899	0.00951	0.00608	0.00674	0.00732	0.00559	0.00854	0.00843	0.00748	0.00676	0.00688
	0.80	0.00504	0.00816	0.00903	0.00581	0.00601	0.00711	0.00504	0.00782	0.00807	0.00637	0.00546	0.00700
	0.30	0.00453	0.00735	0.00764	0.00526	0.00485	0.00584	0.00438	0.00744	0.00760	0.00602	0.00561	0.00611
	0.50	0.00259	0.00442	0.00421	0.00300	0.00326	0.00363	0.00277	0.00451	0.00458	0.00325	0.00312	0.00361
0	0.70	0.00206	0.00298	0.00303	0.00211	0.00224	0.00287	0.00198	0.00295	0.00313	0.00256	0.00234	0.00262
	0.75	0.00184	0.00267	0.00308	0.00207	0.00190	0.00238	0.00184	0.00273	0.00322	0.00223	0.00208	0.00235
	0.80	0.00161	0.00277	0.00274	0.00193	0.00199	0.00213	0.00174	0.00286	0.00296	0.00213	0.00201	0.00226

Table 10.19b

Average Mean Squared Errors of the Estimates of x_i's from the Minres Procedure for Each Combination

n	a	m=10 items						m=15 items					
		Constant x_i's			Varied x_i's			Constant x_i's			Varied x_i's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
	0.30	0.03202	0.05174	0.05059	0.03893	0.04064	0.04806	0.03054	0.05253	0.05338	0.04324	0.03731	0.04048
	0.50	0.01774	0.02595	0.02899	0.01843	0.01930	0.02005	0.01721	0.02532	0.02942	0.02175	0.01976	0.02073
20	0.70	0.01138	0.01939	0.02165	0.01365	0.01354	0.01608	0.01306	0.01775	0.02059	0.01526	0.01355	0.01575
	0.75	0.01047	0.01690	0.01792	0.01212	0.01158	0.01595	0.01144	0.01680	0.01910	0.01418	0.01329	0.01474
	0.80	0.01023	0.01571	0.01666	0.01312	0.01173	0.01385	0.01064	0.01523	0.01624	0.01308	0.01257	0.01309
	0.30	0.01927	0.03511	0.03549	0.02153	0.02084	0.02869	0.02118	0.03338	0.03443	0.02345	0.02376	0.02714
	0.50	0.01118	0.01901	0.01905	0.01296	0.01326	0.01450	0.01147	0.01716	0.01779	0.01413	0.01339	0.01485
30	0.70	0.00874	0.01276	0.01308	0.00861	0.00870	0.01028	0.00822	0.01257	0.01286	0.01022	0.00865	0.00897
	0.75	0.00728	0.01091	0.01251	0.00814	0.00844	0.00897	0.00730	0.01208	0.01178	0.00951	0.00835	0.00930
	0.80	0.00703	0.01195	0.01085	0.00785	0.00793	0.00881	0.00696	0.01027	0.01145	0.00881	0.00814	0.00946
	0.30	0.01445	0.02047	0.02441	0.01701	0.01514	0.01825	0.01569	0.02333	0.02231	0.01827	0.01674	0.01931
	0.50	0.00859	0.01352	0.01472	0.00894	0.00925	0.01123	0.00791	0.01273	0.01426	0.01038	0.00916	0.01073
40	0.70	0.00593	0.00933	0.00972	0.00627	0.00653	0.00740	0.00580	0.00932	0.01000	0.00760	0.00727	0.00749
	0.75	0.00508	0.00891	0.00936	0.00596	0.00669	0.00688	0.00598	0.00847	0.00837	0.00736	0.00671	0.00663
	0.80	0.00502	0.00809	0.00881	0.00574	0.00592	0.00674	0.00502	0.00778	0.00797	0.00630	0.00543	0.00675
	0.30	0.00452	0.00723	0.00752	0.00513	0.00483	0.00568	0.00437	0.00738	0.00751	0.00590	0.00559	0.00587
	0.50	0.00258	0.00438	0.00413	0.00293	0.00321	0.00335	0.00276	0.00448	0.00454	0.00320	0.00310	0.00345
0	0.70	0.00205	0.00293	0.00297	0.00208	0.00222	0.00268	0.00198	0.00293	0.00310	0.00253	0.00233	0.00249
	0.75	0.00183	0.00263	0.00302	0.00203	0.00189	0.00222	0.00183	0.00272	0.00320	0.00221	0.00207	0.00224
	0.80	0.00161	0.00274	0.00268	0.00189	0.00190	0.00200	0.00174	0.00286	0.00293	0.00209	0.00200	0.00215

Table 10.19c

Average Mean Squared Errors of the Estimates of π_t's from the Goodman Procedure for Each Combination

n	h	m=10 items Constant π_t's .20	m=10 items Constant π_t's .40	m=10 items Constant π_t's .50	m=10 items Varied π_t's .10 to .85	m=10 items Varied π_t's .05 to .50	m=10 items Varied π_t's .50 to .95	m=15 items Constant π_t's .20	m=15 items Constant π_t's .40	m=15 items Constant π_t's .50	m=15 items Varied π_t's .10 to .85	m=15 items Varied π_t's .05 to .50	m=15 items Varied π_t's .50 to .95
20	0.30	0.03172	0.04946	0.04743	0.03823	0.04000	0.03936	0.03034	0.05124	0.05114	0.04210	0.03707	0.03545
	0.50	0.01756	0.02408	0.02722	0.01763	0.01898	0.01821	0.01702	0.02441	0.02785	0.02118	0.01945	0.01839
	0.70	0.01113	0.01813	0.01972	0.01316	0.01339	0.01411	0.01277	0.01699	0.01906	0.01479	0.01342	0.01398
	0.75	0.01034	0.01611	0.01675	0.01180	0.01147	0.01282	0.01132	0.01630	0.01800	0.01399	0.01298	0.01310
	0.80	0.01024	0.01450	0.01556	0.01274	0.01155	0.01229	0.01053	0.01454	0.01542	0.01267	0.01228	0.01183
30	0.30	0.01904	0.03329	0.03316	0.02078	0.02040	0.02460	0.02098	0.03262	0.03183	0.02238	0.02355	0.02424
	0.50	0.01106	0.01865	0.01736	0.01253	0.01302	0.01212	0.01132	0.01665	0.01656	0.01371	0.01311	0.01280
	0.70	0.00867	0.01212	0.01224	0.00834	0.00853	0.00920	0.00800	0.01190	0.01223	0.00987	0.00845	0.00802
	0.75	0.00713	0.01064	0.01202	0.00777	0.00834	0.00820	0.00723	0.01148	0.01107	0.00936	0.00812	0.00864
	0.80	0.00693	0.01094	0.01020	0.00762	0.00767	0.00774	0.00695	0.00996	0.01065	0.00855	0.00801	0.00827
40	0.30	0.01430	0.01934	0.02232	0.01650	0.01483	0.01638	0.01538	0.02224	0.02108	0.01804	0.01639	0.01660
	0.50	0.00841	0.01289	0.01387	0.00871	0.00895	0.00951	0.00776	0.01215	0.01308	0.01015	0.00898	0.00960
	0.70	0.00581	0.00862	0.00931	0.00595	0.00628	0.00653	0.00568	0.00896	0.00935	0.00741	0.00723	0.00695
	0.75	0.00501	0.00864	0.00867	0.00579	0.00663	0.00620	0.00553	0.00821	0.00801	0.00716	0.00659	0.00598
	0.80	0.00496	0.00752	0.00830	0.00564	0.00574	0.00609	0.00494	0.00747	0.00769	0.00614	0.00533	0.00625
0	0.30	0.00446	0.00664	0.00711	0.00498	0.00476	0.00501	0.00434	0.00714	0.00710	0.00573	0.00547	0.00521
	0.50	0.00246	0.00420	0.00388	0.00292	0.00309	0.00314	0.00270	0.00433	0.00432	0.00313	0.00307	0.00315
	0.70	0.00200	0.00268	0.00271	0.00204	0.00216	0.00238	0.00195	0.00284	0.00293	0.00247	0.00231	0.00225
	0.75	0.00181	0.00246	0.00281	0.00198	0.00186	0.00206	0.00180	0.00259	0.00304	0.00213	0.00202	0.00200
	0.80	0.00155	0.00258	0.00249	0.00179	0.00192	0.00187	0.00170	0.00278	0.00278	0.00201	0.00199	0.00195

Table 10.19d

Average Mean Squared Errors of the Estimates of x_t's from the Newton-Raphson Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant x_t's			Varied x_t's			Constant x_t's			Varied x_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
	0.30	0.03172	0.04946	0.04744	0.03823	0.04000	0.04413	0.03034	0.05124	0.05114	0.04210	0.03707	0.03477
	0.50	0.01756	0.02408	0.02722	0.01762	0.01898	0.02070	0.01702	0.02441	0.02785	0.02118	0.01945	0.01809
20	0.70	0.01113	0.01813	0.01972	0.01316	0.01339	0.01594	0.01277	0.01699	0.01906	0.01479	0.01342	0.01406
	0.75	0.01034	0.01611	0.01675	0.01180	0.01147	0.01442	0.01132	0.01630	0.01800	0.01399	0.01298	0.01310
	0.80	0.01024	0.01450	0.01556	0.01274	0.01155	0.01379	0.01053	0.01454	0.01542	0.01267	0.01228	0.01165
	0.30	0.01904	0.03330	0.03316	0.02078	0.02039	0.02604	0.02098	0.03262	0.03183	0.02238	0.02355	0.02382
	0.50	0.01106	0.01865	0.01736	0.01252	0.01302	0.01130	0.01132	0.01665	0.01656	0.01371	0.01311	0.01269
30	0.70	0.00867	0.01212	0.01224	0.00834	0.00853	0.01112	0.00800	0.01190	0.01223	0.00987	0.00845	0.00797
	0.75	0.00713	0.01064	0.01202	0.00777	0.00834	0.00794	0.00723	0.01148	0.01107	0.00936	0.00812	0.00862
	0.80	0.00693	0.01094	0.01020	0.00762	0.00767	0.00907	0.00695	0.00996	0.01063	0.00855	0.00801	0.00826
	0.30	0.01430	0.01934	0.02232	0.01650	0.01483	0.01481	0.01538	0.02224	0.02108	0.01804	0.01639	0.01626
	0.50	0.00841	0.01289	0.01387	0.00871	0.00895	0.00914	0.00776	0.01215	0.01308	0.01015	0.00898	0.00956
40	0.70	0.00581	0.00862	0.00931	0.00595	0.00628	0.00733	0.00568	0.00896	0.00935	0.00741	0.00723	0.00695
	0.75	0.00501	0.00864	0.00867	0.00579	0.00663	0.00700	0.00553	0.00821	0.00801	0.00716	0.00659	0.00598
	0.80	0.00496	0.00752	0.00830	0.00564	0.00574	0.00665	0.00494	0.00747	0.00769	0.00614	0.00533	0.00426
	0.30	0.00446	0.00664	0.00711	0.00498	0.00476	0.00507	0.00434	[illegible]	0.00710	0.00573	0.00547	0.00520
	0.50	0.00246	0.00420	0.00388	0.00292	0.00309	0.00314	0.00278	[illegible]	0.00432	0.00313	0.00307	0.00315
0	0.70	0.00200	0.00268	0.00271	0.00204	0.00216	0.00238	0.00195	0.00284	0.00293	0.00247	0.00231	0.00225
	0.75	0.00181	0.00246	0.00281	0.00198	0.00186	0.00206	0.00180	[illegible]	0.00304	0.00213	0.00202	0.00200
	0.80	0.00155	0.00258	0.00249	0.00178	0.00192	0.00187	0.00170	[illegible]	0.00278	0.00201	0.00199	0.00195

Table 10.20

Frequency Distributions of the Average Deviations of the Estimates of x_t's Across All Combinations

Midpt. of Intervals	Estimation Procedures			
	Spearman	Minres	Goodman	N. - R.
-0.08				1
-0.07				
-0.06				1
-0.05		1		2
-0.04	1	10		2
-0.03	10	16	14	21
-0.02	34	46	31	45
-0.01	156	220	168	184
0.00	1892	1968	1951	1919
0.01	647	553	624	619
0.02	187	147	167	164
0.03	59	31	38	35
0.04	11	7	4	4
0.05	1	1	2	2
0.06	2		1	1
Total	3000	3000	3000	3000

Table 10.21a

Mean Average Deviations of the Estimates of z_t's from the Spearman Procedure for Each Combination

		m=10 items						m=15 items					
		Constant z_t's			Varied z_t's			Constant z_t's			Varied z_t's		
n	b	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.00012	-.00177	0.00460	0.00248	0.00082	-.00266	-.00462	0.00877	0.00202	0.00778	-.00068	0.00712
	0.50	0.00524	-.00345	0.00424	0.00815	0.00206	0.00965	0.00244	0.00593	0.00177	0.00411	-.00194	0.00176
	0.70	0.00397	0.00585	0.00402	0.00418	-.00015	-.00249	0.00372	0.00244	0.00168	-.00105	0.00082	0.00097
	0.75	-.00250	0.00663	0.00087	-.00243	-.00148	-.00168	0.00068	0.00164	-.00484	-.00041	0.00973	0.00201
	0.80	0.00445	0.00054	0.00265	0.00284	0.0024[illegible]	0.00389	-.00151	0.00029	-.00072	0.00001	-.00159	-.00019
30	0.30	0.00091	0.01011	0.00055	-.00630	-.00739	0.00546	-.00039	0.00028	-.00068	0.00155	0.00091	0.00666
	0.50	0.00515	0.00349	-.00147	0.00464	-.00022	0.00211	-.00261	0.00747	-.00241	-.00216	-.00185	-.00242
	0.70	-.00059	-.00041	0.00453	0.00452	0.00241	-.00650	0.00262	0.00177	0.00217	-.00128	-.00179	0.00366
	0.75	0.00098	-.00324	0.00349	-.00002	0.00176	0.00208	0.00072	-.00276	-.00077	0.00043	0.00141	-.00025
	0.80	-.00076	0.00379	0.00481	-.00198	-.00154	0.00237	0.00011	-.00612	-.00092	0.00245	0.00012	0.00332
40	0.30	0.00520	0.00395	0.00550	0.00477	-.00622	0.00664	0.00230	0.00500	-.00471	0.00093	-.00065	-.00122
	0.50	0.00246	-.00280	0.00100	0.00449	0.00266	0.00082	0.00140	0.00111	-.00356	-.00629	-.00212	0.00433
	0.70	-.00062	-.00150	-.00252	-.00053	-.00564	0.00335	-.00115	0.00257	-.00516	-.00345	0.00056	0.00296
	0.75	-.00529	-.00054	-.00053	0.00010	0.00251	0.00344	0.00035	-.00194	-.00027	0.00006	-.00160	0.00185
	0.80	0.00136	-.00016	-.00068	0.00202	0.00122	-.00084	0.00228	0.00148	0.00218	-.00147	-.00138	0.00371
120	0.30	-.00265	0.00249	0.00211	0.00357	-.00055	0.00250	0.00139	0.00192	-.00057	0.00114	0.00101	-.00118
	0.50	0.00089	0.00046	-.00207	-.00013	0.00197	0.00165	0.00114	0.00343	-.00066	0.00231	-.00072	0.00055
	0.70	0.00022	0.00159	-.00091	-.00006	0.00076	0.00158	0.00052	0.00170	0.00144	0.00085	0.00021	0.00011
	0.75	0.00058	0.00125	-.00093	0.00180	-.00120	0.00101	0.00136	-.00480	-.00113	-.00002	-.00035	0.00034
	0.80	-.00052	-.00310	0.00064	0.00153	-.00070	-.00075	-.00026	-.00084	-.00132	-.00115	-.00052	-.00230

Table 10.21b

Mean Average Deviations of the Estimates of x_t's from the Minres Procedure for Each Combination

n	h	m=10 items						m=15 items					
		Constant x_t's			Varied x_t's			Constant x_t's			Varied x_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
	0.30	-.00075	-.00690	-.00410	-.00056	-.00130	-.02927	-.00534	0.00471	-.00418	0.00429	-.00183	-.00881
	0.50	0.00465	-.00740	-.00219	0.00501	0.00127	-.00475	0.00204	0.00346	-.00241	0.00247	-.00259	-.00876
20	0.70	0.00354	0.00341	-.00127	0.00285	-.00075	-.01292	0.00329	0.00074	-.00185	-.00212	0.00034	-.00580
	0.75	-.00289	0.00418	-.00278	-.00304	-.00203	-.01299	0.00037	0.00027	-.00785	-.00153	0.00927	-.00540
	0.80	0.00419	-.00209	-.00148	0.00225	0.00198	-.00504	-.00180	-.00131	-.00355	-.00101	-.00231	-.00597
	0.30	0.00023	0.00541	-.00585	-.00811	-.00830	-.01033	-.00093	-.00165	-.00582	-.00110	0.00009	-.00348
	0.50	0.00474	0.00175	-.00596	0.00349	-.00096	-.00618	-.00294	0.00590	-.00576	-.00386	-.00227	-.00937
30	0.70	-.00081	-.00203	0.00117	0.00308	0.00192	-.01141	0.00230	0.00036	0.00010	-.00243	-.00221	-.00132
	0.75	0.00066	-.00439	0.00109	-.00035	0.00126	-.00332	0.00055	-.00408	-.00288	-.00007	0.00085	-.00465
	0.80	-.00105	0.00189	0.00234	-.00287	-.00195	-.00316	-.00003	-.00719	-.00303	0.00169	-.00026	-.00217
	0.30	0.00464	0.00075	-.00033	0.00290	-.00672	-.00260	0.00178	0.00278	-.00787	-.00067	-.00122	-.00951
	0.50	0.00204	-.00451	-.00180	0.00366	0.00232	-.00584	0.00114	-.00021	-.00616	-.00734	-.00246	-.00159
40	0.70	-.00085	-.00307	-.00429	-.00103	-.00622	-.00267	-.00133	0.00168	-.00683	-.00392	0.00030	0.00024
	0.75	-.00552	-.00146	-.00267	-.00054	0.00232	-.00113	0.00022	-.00279	-.00160	-.00053	-.00185	-.00165
	0.80	0.00120	-.00142	-.00265	0.00165	0.00076	-.00440	0.00212	0.00066	0.00097	-.00247	-.00167	0.00069
	0.30	-.00280	0.00116	0.00048	0.00338	-.00080	-.00232	0.00128	0.00127	-.00181	0.00091	0.00077	-.00403
	0.50	0.00074	-.00008	-.00303	-.00072	0.00181	-.00044	0.00106	0.00298	-.00143	0.00219	-.00080	-.00126
120	0.70	0.00013	0.00101	-.00160	-.00028	0.00065	0.00021	0.00046	0.00139	0.00087	0.00055	0.00015	-.00144
	0.75	0.00051	0.00081	-.00171	0.00154	-.00132	-.00079	0.00130	-.00509	-.00161	-.00019	-.00038	-.00123
	0.80	-.00062	-.00348	-.00006	0.00143	-.00087	-.00167	-.00032	-.00106	-.00178	-.00138	-.00059	-.00338

Table 10.21c

Mean Average Deviations of the Estimates of π_i's from the Goodman Procedure for Each Combination

		m=10 items						m=15 items					
		Constant π_i's			Varied π_i's			Constant π_i's			Varied π_i's		
n	k	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.00014	-.00572	0.00458	0.00050	-.00008	-.00896	-.00502	0.00635	0.00161	0.00603	-.00136	-.00405
	0.50	0.00639	-.00205	0.00504	0.00666	0.00208	0.00058	0.00259	0.00548	-.0001[illegible]	0.00226	-.00253	-.00227
	0.70	0.00386	0.00493	-.00032	0.00287	-.00114	-.00387	0.00289	0.00203	-.0002[illegible]	-.00056	0.00059	0.00109
	0.75	-.00281	0.00666	-.00061	-.00225	-.00118	-.00113	0.00069	0.00041	-.00663	0.00040	0.00882	0.00063
	0.80	0.00481	-.00109	-.00141	0.00250	0.00167	-.00377	-.00171	0.00124	-.00402	0.00063	-.00240	-.00280
30	0.30	0.00100	0.00938	0.00223	-.00561	-.00496	-.00030	-.00092	-.00019	-.00131	-.00132	0.00113	0.00062
	0.50	0.00649	0.00147	-.00208	0.00494	-.00135	0.00165	-.00275	0.00609	-.00271	-.00359	-.00156	-.00332
	0.70	-.00099	0.00019	0.00268	0.00245	0.00286	-.00931	0.00251	-.00017	0.00168	-.00251	-.00208	0.00089
	0.75	0.00106	-.00315	0.00180	0.00082	0.00100	-.00204	0.00024	-.00411	-.00218	0.00029	0.00073	-.00270
	0.80	0.00014	0.00363	0.00245	-.00246	-.00049	-.00342	0.00060	-.00679	-.00120	0.00182	-.00021	0.00164
40	0.30	0.00423	0.00363	0.00434	0.00329	-.00358	0.00073	0.00170	0.00389	-.00557	-.00087	-.00009	-.00364
	0.50	0.00169	-.00338	-.00113	0.00514	0.00271	-.00321	0.00087	0.00106	-.00346	-.00652	-.00203	0.00326
	0.70	-.00136	-.00151	-.00120	-.00128	-.00619	-.00005	-.00179	0.00233	-.00345	-.00343	0.00058	0.00047
	0.75	-.00597	0.00019	-.00039	-.00165	0.00244	0.00209	0.00015	-.00183	-.00179	-.00089	-.00146	0.00046
	0.80	0.00230	-.00064	-.00037	0.00223	0.00026	-.00015	0.00228	-.00005	0.00163	-.00252	-.00149	0.00063
120	0.30	-.00279	0.00149	0.00097	0.00415	-.00091	0.00121	0.00089	0.00138	0.00011	0.00135	0.00147	-.00037
	0.50	0.00075	-.00024	-.00121	-.00024	0.00211	-.00094	0.00115	0.00332	-.00168	0.00312	-.00118	0.00052
	0.70	0.00027	0.00132	-.00011	0.00009	0.00103	0.00036	0.00031	0.00149	0.00132	0.00070	-.00009	-.00009
	0.75	0.00071	0.00088	-.00186	0.00145	-.00121	0.00011	0.00075	-.00462	-.00094	-.00056	0.00003	-.00035
	0.80	-.00089	-.00400	0.00061	0.00187	-.00064	0.00033	-.00029	0.00005	-.00123	-.00118	-.00003	-.00221

Table 10.21d

Mean Average Deviations of the Estimates of π_t's from the Newton-Raphson Procedure for Each Combination

n	b	m=10 items						m=15 items					
		Constant π_t's			Varied π_t's			Constant π_t's			Varied π_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	0.00014	-.00574	0.00446	0.00044	-.00009	-.04324	-.00502	0.00635	0.00161	0.00603	-.00136	-.01344
	0.50	0.00639	-.00207	0.00504	0.00639	0.00207	-.02350	0.00257	0.00318	-.00014	0.00226	-.00253	-.00333
	0.70	0.00386	0.00493	-.00032	0.00285	-.00114	-.01704	0.00289	0.00203	-.00025	-.00056	0.00059	0.00020
	0.75	-.00281	0.00666	-.00061	-.00228	-.00119	-.01293	0.00069	0.00041	-.00663	0.00040	0.00882	-.00007
	0.80	0.00481	-.00109	-.00141	0.00248	0.00167	-.01039	-.00171	0.00124	-.00402	0.00063	-.00240	-.00311
30	0.30	0.00100	0.00937	0.00220	-.00567	-.00497	-.02256	-.00092	-.00019	-.00130	-.00153	0.00113	-.00351
	0.50	0.00649	0.00147	-.00208	0.00490	-.00135	-.00654	-.00275	0.00609	-.00271	-.00359	-.00156	-.00315
	0.70	-.00099	0.00019	0.00268	0.00243	0.00286	-.01232	0.00251	-.00017	0.00168	-.00251	-.00208	0.00141
	0.75	0.00106	-.00315	0.00180	0.00081	0.00100	-.00510	0.00024	-.00411	-.00218	0.00029	0.00073	-.00184
	0.80	0.00014	0.00363	0.00245	-.00247	-.00049	-.00506	0.00060	-.00679	-.00120	0.00182	-.00021	0.00230
40	0.30	0.00423	0.00365	0.00433	0.00326	-.00358	-.00770	0.00170	0.00389	-.00557	-.00088	-.00009	-.00262
	0.50	0.00189	-.00338	-.00113	0.00512	0.00271	-.00406	0.00087	0.00106	-.00346	-.00652	-.00203	0.00434
	0.70	-.00136	-.00151	-.00120	-.00129	-.00619	-.00026	-.00179	0.00233	-.00345	-.00343	0.00058	0.00115
	0.75	-.00597	0.00019	-.00039	-.00165	0.00244	-.00156	0.00015	-.00183	-.00179	-.00089	-.00146	0.00114
	0.80	0.00230	-.00064	-.00037	0.00223	0.00026	0.00260	0.00228	-.00005	0.00163	-.00252	-.00149	0.00071
120	0.30	-.00279	0.00149	0.00099	0.00414	-.00091	0.00315	0.00089	0.00138	0.00011	0.00135	0.00147	0.00006
	0.50	0.00075	-.00024	-.00121	-.00024	0.00211	-.00026	0.00115	0.00332	-.00168	0.00312	-.00118	0.00060
	0.70	0.00027	0.00132	-.00011	0.00009	0.00103	0.00036	0.00031	0.00149	0.00132	0.00070	-.00009	-.00004
	0.75	0.00071	0.00088	-.00186	0.00145	-.00121	0.00011	0.00075	-.00462	-.00094	-.00036	0.00003	-.00034
	0.80	-.00089	-.00400	0.00061	0.00187	-.00064	0.00033	-.00029	0.00005	-.00123	-.00118	-.00003	-.00221

Summary and Conclusions. In this study, we have used the Monte Carlo method to examine four different procedures for estimating the parameters for the primitive model as it applied to the Equivalence study. The primitive model characterizes a student's response to an item drawn from the item domain. In this model, there are two types of parameters for each item: the parameter k refers to the proportion of students belonging to the (+) category, i.e., those who can respond correctly to the item, and the parameter x_t refers to the conditional probability of an error by a member of the (+) category. Significantly, the model assumes that no guessing is possible. In the Equivalence study, it is further assumed that the parameter k is constant across items but the x_t's for each item might differ. That is, under the conditions of no learning or systematic change in behavior, the item responses to different items are "equivalent in k." It may be said that k characterizes the generic task represented by the item domain and the x_t's characterize the specific task represented by the items.

By using the Monte Carlo method, we examined the estimates from the four procedures under a variety of conditions by systematically varying the sample size (n), the number of items in the test (m), and the parameters k and x_t's. These conditions were selected to approximate situations most common to classroom testing, i.e., short tests with small numbers of students. The results of the Monte Carlo study indicate that the estimates are in close agreement among the four procedures. Examination of the mean squared errors and the average deviations of the estimates from the parameters also suggests that the estimates are consistent and the biases are small in magnitude. For both k and x_t's differences between the mean squared errors and the variances of the estimates average approximately 1% of the mean squared errors for all four procedures. The estimates agree with the parametric value to three decimal-place digits on the average.

In addition, the MSE's (and the variances) of the estimates were found to be related to both n and k. While the MSE's for the estimates of k and x_t's decrease with increases in n, the MSE's for x_t's decrease as k increases. The MSE's for the estimates of k are a quadratic function of k. That is, the MSE's increase as k approaches 0.50. Note that the MSE's of k are generally smaller than those of x_t's. The MSE's (and the variances) are approximated quite well by using the binomial formula of variances in k. As was pointed out above, the asymptotic variance of k for m = 2 is

$$\mathrm{var}_\infty(\hat{k}) = \frac{\hat{k}(1 - \hat{k})}{n} + \frac{\hat{k}\hat{x}_1\hat{x}_2}{n(1 - \hat{x}_1)(1 - \hat{x}_2)} .$$

The first part of the right-hand side is exactly the formula for the variance of a binomial variate. When the values of x_1 and x_2 are large, the second term of the formula will make a significant contribution to the value of the variance. Since we are not able to derive a closed-form solution for k when m is greater than 2, it is not clear how the values of the x_t's would affect the values of the variances. The results of the Monte Carlo study suggest, however, that this contribution may be small in magnitude. At the same time, a comparison of the estimated variances, using the binomial formula with the average variance across the set of x_t's (see Table 10.10), shows that the approximations are very good even for small sample sizes. This is a valuable piece of information because we expect that the application of this model will be for situations involving a small number of examinees. If indeed the variances can be approximated by using the formula for the variance of a binomial variate, it can provide a way to generate a confidence interval for the estimates.

The maximum likelihood estimator of k is asymptotically and normally distributed. Although this is a large sample approximation, we can still use the normal distribution for approximating the confidence intervals. For example, the interval

$$\hat{k}-2\sqrt{\frac{\hat{k}(1-\hat{k})}{n-1}} \le k \le \hat{k}+2\sqrt{\frac{\hat{k}(1-\hat{k})}{n-1}}$$

is an approximately 95% confidence interval. But since var($\hat{k}$) is dependent on $\hat{k}$, by applying the arcsine transformation on $\hat{k}$, the transformed variate has an asymptotic variance of 1/4 which is independent of $\hat{k}$. A more stable transformation for moderate sample size suggested by Anscombe (1948) is

$$\sin^{-1}\sqrt{\frac{n\hat{k}+\frac{3}{8}}{n+\frac{3}{4}}}\ .$$

This has an asymptotic variance of 1/(4n+2). Thus, for an approximately 95% confidence interval, the equation will be

$$\sin^{-1}\sqrt{\frac{n\hat{k}+\frac{3}{8}}{n+\frac{3}{4}}} \pm \frac{2}{\sqrt{4n+2}}\ .$$

To demonstrate, we have calculated the 95% confidence interval for each estimate of k for all combinations. The percentage of times that the true parametric values of k (that is, $\sin^{-1}k^{1/2}$), fall within this interval is noted and summarized for each combination of n, k, m and the choice of x_t's. These are summarized in Tables 10.22 a-d for the four procedures, and the frequency distributions of the percentages are reported in Table 10.23 for the four procedures. As shown in Table 10.23, 92.1%, 94.6%, 95.4% and 94.2% of the combinations, respectively, for the Spearman, Minres, Goodman, and Newton-Raphson procedures have at least 95% of the true values of k within the intervals. The average percentages are 97.06, 97.33, 97.48, and 97.41, respectively, for the four procedures. Examining Tables 10.22 a-d reveals that the approximations work best when the sample size is 120 and worst when the sample size is 30.

Table 10.22a

Percentage of the Parameter k Falling Within the Confidence Intervals Generated by the Estimates of k from the Spearman Procedure for Each Combination

n	k	m=10 items						m=15 items					
		Constant x_t's			Varied x_t's			Constant x_t's			Varied x_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	99.0	99.0	99.0	98.0	97.0	95.0	98.0	97.0	98.0	98.0	97.0	97.0
	0.50	98.0	99.0	96.0	99.0	98.0	97.0	99.0	99.0	98.0	98.0	98.0	98.0
	0.70	100.0	97.0	95.0	97.0	96.0	95.0	97.0	97.0	99.0	97.0	99.0	97.0
	0.75	98.0	99.0	97.0	98.0	98.0	97.0	98.0	96.0	100.0	98.0	98.0	95.0
	0.80	99.0	94.0	95.0	99.0	94.0	88.0	97.0	96.0	94.0	95.0	99.0	96.0
30	0.30	96.0	98.0	96.0	100.0	100.0	98.0	96.0	94.0	96.0	98.0	96.0	99.0
	0.50	100.0	99.0	94.0	99.0	99.0	95.0	98.0	98.0	98.0	95.0	97.0	99.0
	0.70	99.0	98.0	98.0	97.0	98.0	91.0	96.0	98.0	97.0	97.0	98.0	93.0
	0.75	98.0	96.0	96.0	96.0	93.0	94.0	99.0	100.0	98.0	98.0	96.0	94.0
	0.80	99.0	97.0	96.0	99.0	97.0	88.0	99.0	92.0	98.0	97.0	96.0	97.0
40	0.30	96.0	99.0	98.0	98.0	98.0	97.0	96.0	100.0	98.0	99.0	97.0	97.0
	0.50	100.0	96.0	97.0	99.0	96.0	97.0	100.0	98.0	100.0	96.0	96.0	97.0
	0.70	97.0	98.0	100.0	95.0	97.0	87.0	94.0	96.0	99.0	97.0	96.0	95.0
	0.75	96.0	97.0	95.0	93.0	97.0	91.0	100.0	98.0	97.0	97.0	96.0	98.0
	0.80	97.0	99.0	97.0	98.0	98.0	96.0	96.0	97.0	100.0	97.0	97.0	98.0
120	0.30	99.0	99.0	97.0	97.0	95.0	97.0	97.0	98.0	98.0	97.0	96.0	98.0
	0.50	97.0	98.0	97.0	97.0	96.0	100.0	97.0	100.0	97.0	98.0	97.0	97.0
	0.70	96.0	99.0	98.0	96.0	98.0	96.0	99.0	97.0	97.0	97.0	97.0	98.0
	0.75	99.0	93.0	95.0	93.0	99.0	96.0	99.0	95.0	96.0	96.0	97.0	95.0
	0.80	97.0	95.0	94.0	99.0	98.0	89.0	99.0	100.0	99.0	100.0	99.0	96.0

Table 10.22b.

Percentage of the Parameter k Falling Within the Confidence Intervals Generated by the Estimates of k from the Minres Procedure for Each Combination

n	k	m=10 items						m=15 items					
		Constant π_i's			Varied π_i's			Constant π_i's			Varied π_i's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	99.0	99.0	99.0	98.0	98.0	93.8	98.0	98.0	98.0	98.0	97.0	99.0
	0.50	98.0	99.0	96.0	99.0	98.0	97.9	99.0	99.0	98.0	97.0	98.0	98.0
	0.70	100.0	97.0	97.0	97.0	96.0	94.9	97.0	96.0	99.0	97.0	99.0	97.0
	0.75	98.0	100.0	98.0	98.0	98.0	97.0	98.0	96.0	100.0	98.0	98.0	98.0
	0.80	95.0	95.0	96.0	99.0	95.0	94.0	99.0	97.0	97.0	96.0	99.0	97.0
30	0.30	96.0	97.0	96.0	100.0	100.0	98.0	96.0	95.0	97.0	97.0	96.0	100.0
	0.50	100.0	99.0	95.0	99.0	99.0	95.0	98.0	98.0	98.0	95.0	97.0	99.0
	0.70	99.0	98.0	98.0	98.0	98.0	93.0	96.0	98.0	97.0	97.0	98.0	93.0
	0.75	98.0	96.0	97.0	96.0	94.0	97.0	99.0	100.0	98.0	98.0	96.0	96.0
	0.80	99.0	97.0	96.0	98.0	97.0	91.0	99.0	93.0	98.0	97.0	96.0	99.0
40	0.30	96.0	99.0	98.0	98.0	98.0	97.0	96.0	100.0	98.0	100.0	97.0	98.0
	0.50	100.0	96.0	96.0	99.0	97.0	97.0	100.0	98.0	100.0	96.0	96.0	98.0
	0.70	97.0	98.0	100.0	94.0	97.0	93.0	94.0	96.0	99.0	98.0	96.0	96.0
	0.75	96.0	97.0	96.0	93.0	97.0	92.0	100.0	98.0	98.0	99.0	96.0	100.0
	0.80	97.0	99.0	97.0	98.0	98.0	97.0	96.0	97.0	100.0	98.0	97.0	95.0
120	0.30	99.0	99.0	96.0	98.0	95.0	98.0	97.0	98.0	98.0	97.0	96.0	98.0
	0.50	97.0	98.0	97.0	98.0	96.0	98.0	97.0	100.0	97.0	98.0	97.0	97.0
	0.70	96.0	98.0	98.0	96.0	99.0	97.0	99.0	97.0	97.0	97.0	97.0	98.0
	0.75	99.0	95.0	96.0	95.0	99.0	95.0	99.0	95.0	97.0	96.0	97.0	96.0
	0.80	97.0	95.0	94.0	99.0	99.0	91.0	99.0	100.0	99.0	99.0	99.0	96.0

Table 10.22c

Percentages of the Parameter k Falling Within the Confidence Intervals Generated by the Estimates of k from the Goodman Procedure for Each Combination

n	k	m=10 items						m=15 items					
		Constant x_t's			Varied x_t's			Constant x_t's			Varied x_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	99.0	99.0	99.0	98.0	98.0	95.9	98.0	98.0	98.0	98.0	97.0	99.0
	0.50	98.0	99.0	97.0	99.0	98.0	96.0	99.0	99.0	98.0	97.0	98.0	99.0
	0.70	100.0	97.0	96.0	97.0	95.0	95.0	97.0	94.0	98.0	97.0	97.0	99.0
	0.75	98.0	99.0	98.0	97.0	98.0	99.0	98.0	96.0	100.0	98.0	98.0	100.0
	0.80	99.0	98.0	98.0	99.0	97.0	95.8	99.0	98.0	97.0	99.0	99.0	99.0
30	0.30	96.0	98.0	97.0	100.0	100.0	97.0	96.0	95.0	97.0	98.0	96.0	100.0
	0.50	100.0	99.0	96.0	99.0	99.0	98.0	98.0	98.0	98.0	95.0	97.0	99.0
	0.70	99.0	98.0	98.0	98.0	97.0	96.0	96.0	98.0	97.0	97.0	98.0	94.0
	0.75	96.0	92.0	96.0	92.0	93.0	99.0	98.0	98.0	95.0	98.0	95.0	96.0
	0.80	99.0	95.0	94.0	97.0	95.0	95.7	99.0	91.0	95.0	97.0	94.0	95.0
40	0.30	97.0	99.0	99.0	98.0	99.0	97.0	97.0	100.0	99.0	100.0	99.0	97.0
	0.50	100.0	97.0	95.0	99.0	97.0	98.0	100.0	98.0	100.0	97.0	96.0	99.0
	0.70	97.0	98.0	100.0	95.0	96.0	93.0	94.0	96.0	98.0	98.0	96.0	99.0
	0.75	99.0	99.0	97.0	97.0	98.0	98.0	100.0	98.0	99.0	99.0	96.0	97.0
	0.80	97.0	100.0	98.0	98.0	98.0	100.0	96.0	97.0	100.0	97.0	97.0	98.0
120	0.30	99.0	99.0	98.0	98.0	96.0	100.0	97.0	98.0	98.0	98.0	96.0	97.0
	0.50	97.0	97.0	97.0	97.0	96.0	100.0	97.0	100.0	96.0	97.0	97.0	98.0
	0.70	95.0	99.0	98.0	96.0	98.0	95.0	99.0	96.0	96.0	97.0	97.0	99.0
	0.75	98.0	96.0	98.0	96.0	100.0	95.0	99.0	95.0	97.0	97.0	97.0	96.0
	0.80	97.0	96.0	96.0	99.0	99.0	92.0	99.0	100.0	100.0	99.0	99.0	97.0

Table 10.22d

Percentages of the Parameter k Falling Within the Confidence Intervals Generated by the Estimates of k from the Newton-Raphson Procedure for Each Combination

n	k	m=10 items						m=15 items					
		Constant π_t's			Varied π_t's			Constant π_t's			Varied π_t's		
		.20	.40	.50	.10 to .85	.05 to .50	.50 to .95	.20	.40	.50	.10 to .85	.05 to .50	.50 to .95
20	0.30	99.0	99.0	99.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	97.0	97.6
	0.50	98.0	99.0	97.0	99.0	98.0	98.3	99.0	99.0	98.0	97.0	98.0	99.0
	0.70	100.0	97.0	96.0	97.0	95.0	94.1	97.0	94.0	98.0	97.0	99.0	99.0
	0.75	98.0	99.0	98.0	97.0	98.0	98.6	98.0	96.0	100.0	98.0	98.0	100.0
	0.80	99.0	98.0	98.0	99.0	97.0	94.1	99.0	98.0	97.0	99.0	99.0	95.9
30	0.30	96.0	98.0	97.0	100.0	100.0	96.5	96.0	95.0	97.0	98.0	96.0	100.0
	0.50	100.0	99.0	96.0	99.0	99.0	95.7	98.0	98.0	98.0	95.0	97.0	99.0
	0.70	99.0	98.0	98.0	98.0	97.0	96.5	96.0	98.0	97.0	97.0	98.0	92.9
	0.75	96.0	92.0	96.0	92.0	93.0	97.5	98.0	98.0	95.0	98.0	95.0	96.0
	0.80	99.0	95.0	94.0	97.0	95.0	91.0	99.0	91.0	95.0	97.0	94.0	95.0
40	0.30	97.0	99.0	99.0	98.0	99.0	97.2	97.0	100.0	99.0	100.0	99.0	96.9
	0.50	100.0	97.0	95.0	99.0	97.0	96.5	100.0	98.0	100.0	97.0	96.0	99.0
	0.70	97.0	98.0	100.0	95.0	96.0	93.8	94.0	96.0	98.0	98.0	96.0	99.0
	0.75	99.0	99.0	97.0	97.0	98.0	97.6	100.0	98.0	99.0	99.0	96.0	97.0
	0.80	97.0	100.0	98.0	98.0	98.0	95.5	96.0	97.0	100.0	97.0	97.0	98.0
120	0.30	99.0	99.0	98.0	98.0	96.0	100.0	97.0	98.0	98.0	98.0	96.0	97.0
	0.50	97.0	97.0	97.0	97.0	96.0	100.0	97.0	100.0	96.0	97.0	97.0	98.0
	0.70	95.0	99.0	98.0	96.0	98.0	95.0	99.0	96.0	96.0	97.0	97.0	99.0
	0.75	98.0	96.0	98.0	96.0	100.0	95.0	99.0	95.0	97.0	97.0	97.0	96.0
	0.80	97.0	96.0	96.0	99.0	99.0	92.0	99.0	100.0	100.0	99.0	99.0	97.0

Table 10.23

Frequency Distributions of the Percentages of the Parameter b Falling Within the Confidence Intervals Generated by the Estimates of b Across All Combinations

% of b fell within the intervals for each Combination	Estimation Procedures			
	Spearman	Minres	Goodman	N. - R.
87%	1			
88%	2			
89%	1			
90%	0			
91%	2	2	1	2
92%		1	3	3
93%	3	5	2	2
94%	9	5	5	7
95%	18	14	16	15
96%	38	40	33	32
97%	58	52	50	51
98%	51	61	57	59
99%	39	41	50	47
100%	17	19	23	22
Total	240	240	240	240

The estimates produced by the four estimation procedures are in close agreement. It is possible that this is due to the use of the Spearman solution for initial estimates for the interactive procedures. With different initial estimates then, the question is whether the iterative procedures will produce different estimates. This does not seem to be the case. Both the Goodman and Newton-Raphson procedures are invariant with respect to the initial choices of estimates. This implies that irrespective of the initial estimates, the two procedures will converge to the same estimates.

In our examination of the sum of squared residuals (SSR's) for the Minres procedure, we note that the SSR's increase with the increase of k and m (the number of items), but decrease with the increase in the sample size n. We also note that the SSR's may be a quadratic function of x. Such systematic variation could be due to the fact that the Minres procedure is applied to the matrix of the first- and second-order joint sample moments of the item responses. The changes in the SSR's may be reflecting the fact that as more information is used from the data, the SSR's become more sensitive to the variations in the parameters.

The four procedures produce estimates in close agreement. The Goodman procedure, using the Spearman solution as an initial estimate, is preferred. It is preferred over the other two iterative procedures because of its relative ease of implementation and speed of convergence. For the particular conditions we have considered in the present study, the Goodman procedure is most likely to converge after two trials. It is preferred over the Spearman solution because the estimates obtained from the Goodman procedure maximize the likelihood function, and consequently, have well-established properties such as consistency and asymptotic normality. These properties apply also to situations that are not covered in the present study. Even for small samples, these properties seem to hold true. This should not minimize the relative merit of the Spearman solution, however. The appeal of the Spearman solution is its simplicity. Although we have presented the Spearman solution in matrix form, close examination will reveal that it can be obtained by hand. For it is simply an averaging procedure involving only [m(m-1)]/2 entries in the matrix of the first- and second-order joint sample moment of the item responses. With its estimates in close agreement to the Goodman procedure, it could be used as an approximation to the maximum likelihood estimates.

Examination of the likelihood function reveals that the maximum likelihood estimator for k must satisfy the following equation:

$$k^m - \prod_{t=1}^{m} \left(k - \frac{f_t}{n}\right) - k^{m-1}\left(1 - \frac{f_0}{n}\right) = 0.$$

And the estimators for the x_t's will be

$$x_t = \frac{1}{\hat{k}}\left(\hat{k} - \frac{f_t}{n}\right), \quad t = 1, 2, 3, \ldots, m.$$

This suggests a way to obtain the maximum likelihood estimators for the model. That is, we could use numerical methods to obtain the m-1 roots of the first equation and select the one that would maximize the likelihood function. It is likely that this method is more efficient than the Goodman procedure if a simple objective function can be found to determine the root of equations that maximize the likelihood function. Further investigation along this line deserves some attention.

One important factor that limits the generalization of the results from the present Monte Carlo study is the lack of information about the distribution of x_t's within an item domain. In the present study, we have arbitrarily selected different sets of x_t's to study their effects on the estimation of k. There is no theoretical justification for the choices; only practical consideration. As we have observed, the choices of x_t's did affect the estimation procedures. For example, the extreme choices for the value of x_t's are related to the number of failures to converge for the three iterative procedures. For the Minres and Newton-Raphson procedures we find that the different sets of x_t's are related to the estimates of k. Moreover, the SSR's for the Minres procedure are also related to the characteristics of the sets of x_t's. These all point toward the need for information about the distribution of x_t's within an item domain. If such information were available, we could have selected the values of x_t's randomly from the distribution. This would greatly enhance the applicability of the results of the present study. Such information, however, can only be obtained from applications in real situations. As we mentioned previously, while the estimates for the individual x_t's were not quite as good as those for k, the estimates for the means of the sets of x_t's were quite good. By using the means and variances of the estimates of x_t's from real applications, we could randomly select values from distributions with similar means and variances. Of course, to determine the shape of the distribution, a sizeable number of items from the item domain must be used. This could be done through matrix sampling.

Since the parameters k and x_t's have meaningful interpretation for a domain of items and can be used as indices for the items in the domain, they can also be used as an instructional tool for the teacher in developing the instructional program. The estimates of k and x_t could suggest that relatively poor performance on an item is primarily a function of lack of familiarity with the specific replacement set, or instead is primarily a function of unfamiliarity with the generic task represented by the item domain. Procedures could then be selected to improve performance by emphasizing the relevant instruction. With the results of the Monte Carlo method, it is safe to suggest the use of the estimation procedure in classroom situations, that is, short tests with small numbers of students. Of course, only experience can indicate the effectiveness of such applications for instructional development.

References for Section II

Anderson, T.W. Some scaling models and estimation procedures in the latent class model. In Ulf Grenander (Ed.), *Probability and Statistics*. New York: Wiley and Sons, 1959, pp. 9-38.

Anscombe, F.J. The transformation of Poisson, binomial, and negative-binomial data. *Biometrika*, 1948, *35*, 246-254.

Comrey, A.L. The minimum residual method of factor analysis. *Psychol. Rep.*, 1962, *11*, 15-18.

Comrey, A.L., and A. Ahumada. An improved procedure and program for minimum residual factor analysis. *Psychol. Rep.*, 1964, *15*, 91-96.

Dempster, A.P., N.M. Laird and D.B. Rubin. Maximum likelihood from incomplete data via the EM algorithm. *J. Royal Statist. Soc.*, 1977, *39*, Series B, 1-22. Discussion, 22-37.

Goodman, L.A. The analysis of systems of qualitative variables when some of the variables are unobservable, I: a modified latent structure approach. *Am. J. Soc.*, 1974a, *79*, 1179-1259.

Goodman, L.A. Exploratory talent structure analysis using both identifiable and unidentifiable models. *Biometrika*, 1974b, *61*, 215-231.

Goodman, L.A. *Analyzing Qualitative/Categorical Data*. Cambridge, Mass.: ABT Books, 1978.

Goodman, L.A. A note on the estimation of parameters in latent structure analysis. *Psychometrika*, 1979, *44*, 123-128.

Hammersley, J., and D. Handscomb. *Monte Carlo Methods*. London: Methuen, 1964.

Harman, H.H. *Modern Factor Analysis* (2nd ed.). Chicago: University of Chicago Press, 1967.

Harman, H.H., and Y. Fukuda. Resolution of the Heywood case in the Minres solution. *Psychometrika*, 1966, *31*, 563-571.

Harman, H.H., and W.H. Jones. Factor analysis by minimizing residual (Minres). *Psychometrika*, 1966, *31*, 351-368.

Hildebrand, D.K., J.D. Laing and H. Rosenthal. *Prediction Analysis of Cross Classifications*. New York: Wiley and Sons, 1977.

International Mathematical and Statistical Libraries, Inc., 7th ed., 1979.

Kale, B.K. On the solution of likelihood equations by iteration processes. The multiparametric case. *Biometrika*, 1962, *49*, 479-486.

Kendall, M.G., and A. Stuart. *The Advanced Theory of Statistics*. *Vol. 2: Inference and Relationship* (3rd ed.). London: Griffin, 1973.

Kleijnen, J.P.C., *Statistical Techniques in Simulation, Part I*. Marcel Dekker, 1974.

Knuth, D. *Seminumerical Algorithms*. Reading, Mass.: Addison-Wesley, 1969.

Lazarsfeld, P.F. The logical and mathematical foundation of latent structure analysis. In S.A. Stouffer, et al., *Studies in Social Psychology in World War II*. *Vol. 4*: *Measurement and Prediction*. Princeton, N.J.: Princeton University Press, 1950, Chap. 10.

Lazarsfeld, P.F. Latent structure analysis. In S. Koch (Ed.), *Psychology: A Study of a Science, Vol. 3*. New York: McGraw-Hill, 1959, pp. 476-535.

Lazarsfeld, P.F., and N.W. Henry. *Latent Structure Analysis*. Boston: Houghton Mifflin, 1968.

Learmonth, G.P., and P.A.W. Lewis. Statistical tests of some widely used and recently proposed uniformed random number generators. NPS55LW73111A. Monterey, Ca.: Naval Postgraduate School, 1973.

Lord, F.M., and M.R. Novick. *Statistical Theories of Mental Test Scores*. Reading, Mass.: Addison-Wesley, 1968.

Marsaglia, G., and T.A. Bray. One-line random number generators and their use in combinations. *Comm. ACM*, 1968, *11*, 757-759.

McHugh, R.B. Efficient estimation and local identification in latent class analysis. *Psychometrika*, 1956, *21*, 331-347.

McHugh, R.B. Note on "Efficient estimation and local identification in latent class analysis." *Psychometrika*, 1958, *23*, 273-274.

Morrison, D.F. *Multivariate Statistical Methods*. New York: McGraw-Hill, 1971.

Mulaik, S.A. *The Foundations of Factor Analysis*. New York: McGraw-Hill, 1972.

Rao, C.R. Methods of scoring linkage data giving the simultaneous segregation of these factors. *Heredity*, 1950, *4*, 37-59.

Rao, C.R. *Linear Statistical Inference and its Applications*, 2nd ed. New York: Wiley and Sons, 1973.

SAS *User's Guide, 1979 Edition*. Raleigh, N.C.: SAS Institute, Inc., 1979.

Shreider, Y.A. (Ed.), *Method of Statistical Testing: Monte Carlo Method*. Amsterdam: Elsevier, 1964.

Thurstone, L.L. A method of factoring without communalities. In *1954 Invitational Conference on Testing Problems*. Princeton, N.J.: Educational Testing Service, 1955, 59-62.

APPENDIX I

The First and Second Partial Derivatives of the log Likelihood Function for The Newton-Raphson Method

In the Newton-Raphson method, the additive correction is calculated from the first and second partial derivatives of the log likelihood function. As shown in Chapter 8, the log likelihood function is

$$\begin{aligned}\log \underline{L} = \text{const} &+ f_0 \log(1-k+k\prod_{i=1}^{m} x_i) \\ &+ (n-f_0)\log k + \sum_{i=1}^{m} f_i \log(1-x_i) \\ &+ \sum_{i=1}^{m} (n-f_0-f_i) \log x_i .\end{aligned}$$

Let the vector Θ be the column vector representing the m+1 parameters, with elements:

$\Theta_0 = k$, and

$\Theta_i = x_i$, for $i=1, 2, \cdots, m$.

The efficient score $S(\Theta)$, is the column matrix of the first partial derivatives of the log likelihood function with respect to Θ. That is,

$$S(\Theta) = [[s_i]] = \left\| \frac{\partial \log L}{\partial \Theta_i} \right\| ,$$

where $s_0 = \frac{\partial \log L}{\partial \theta_0} = \frac{\partial \log L}{\partial k}$

$$= \frac{n-f_0}{k} - \frac{(1-\prod_{t=1}^{m} x_t)f_0}{1-k+k\prod_{t=1}^{m} x_t} \text{ , and}$$

$$s_i = \frac{\partial \log L}{\partial \theta_i} = \frac{\partial \log L}{\partial x_i}$$

$$= \frac{n-f_0-f_i}{x_i} - \frac{f_i}{1-x_i} + \frac{f_0 k(\prod_{t=1}^{m} x_t)}{(1-k+k\prod_{t=1}^{m} x_t)x_i}$$

for $i=1, 2, \ldots, m$.

And the matrix of second partial derivatives of the log likelihood function, $M(\theta)$, is

$$M(\theta) = [[m_{ij}]] = \left\|\frac{\partial^2 \log L}{\partial \theta_i \partial \theta_j}\right\| ,$$

where $m_{oo} = \frac{\partial^2 \log L}{\partial \theta_0^2} = \frac{\partial^2 \log L}{\partial k^2}$

$$= -\frac{n-f_0}{k^2} - \frac{(1-\prod_{t=1}^{m} x_t)^2 f_0}{(1-k+k\prod_{t=1}^{m} x_t)^2} ,$$

$$m_{i0} = m_{0i} = \frac{\partial^2 \log L}{\partial\theta_0 \partial\theta_i} = \frac{\partial^2 \log L}{\partial k \partial x_i}$$

$$= \frac{f_0 \prod_{t=1}^{m} x_t}{x_i \left(1-k+k \prod_{t=1}^{m} x_t\right)^2}, \text{ for } i=1, 2, \ldots, m,$$

$$m_{ii} = \frac{\partial^2 \log L}{\partial\theta_i^2} = \frac{\partial^2 \log L}{\partial x_i^2}$$

$$= -\frac{n-f_0-f_i}{x_i^2} - \frac{f_i}{(1-x_i)^2} - \frac{f_0\left(k \prod_{t=1}^{m} x_t\right)^2}{x_i^2\left(1-k+k \prod_{t=1}^{m} x_t\right)^2},$$

for $i=j=1, 2, \ldots, m$,

and

$$m_{ij} = m_{ji} = \frac{\partial^2 \log L}{\partial\theta_i \partial\theta_j} = \frac{\partial^2 \log L}{\partial x_i \partial x_j}$$

$$= \frac{f_0 (1-k) k \prod_{t=1}^{m} x_t}{x_i x_j \left(1-k+k \prod_{t=1}^{m} x_t\right)^2},$$

for $i \neq j=1, 2, \ldots, m$.

APPENDIX II

FORTRAN Program used to Generate the Response Data and to Estimate the Parameters of the Primitive Model

```
      INTEGER CON(2),S,A
      DATA S,A/'SIMU','ANAL'/
      WRITE(6,3000)
      READ(5,2000,END=45) CON
      GO TO 7
5     READ(5,2000,END=40) CON
7     IF(CON(1).EQ.S) GO TO 10
      IF(CON(1).EQ.A) GO TO 20
      GO TO 30
10    CALL SIMULA
      GO TO 25
20    CALL ESTIMA
25    WRITE(6,3001)CON
      GO TO 5
30    WRITE(6,3002)CON
      GO TO 50
40    WRITE(6,3003)
      GO TO 50
45    WRITE(6,3004)
2000  FORMAT(2A4)
3000  FORMAT('1'/'0',5X,'***** ACHIEVEMENT TEST ',
     *  'ITEM RESPONSES.  WRITTEN BY RICHARD T. HOUANG, UCSB.'/
     *  6X,'***** VERSION - V. FEBRUARY 8, 1980.'/
     *  6X,'***** PROGRAM LIMITS: N = 120, M = 20, DEL= 1.D-6')
3001  FORMAT('1',5X,'***** ',2A4,' WAS REQUESTED.'/
     *  '0',5X,'***** PROGRAM TERMINATED NORMALLY.')
3002  FORMAT('0',5X,'***** ',2A4,' WAS REQUESTED.'/
     *  '0',5X,'***** COMMAND NO AVAILABLE.'/
     *  '0',5X,'***** COMMANDS AVAILABLE: SIMULATE OR ANALYZE.'/
     *  '0',5X,'***** PROGRAM TERMINATED NORMALLY.')
3003  FORMAT('0',5X,'***** NO OTHER COMMAND WAS REQUESTED.'/
     *  '0',5X,'***** PROGRAM TERMINATED NORMALLY.')
3004  FORMAT('0',5X,'***** NO COMMAND WAS REQUESTED.'/
     *  '0',5X,'***** PROGRAM TERMINATED NORMALLY.')
50    STOP
      END
      SUBROUTINE SIMULA
      INTEGER F(232).Z(20.120).REP.MAX.B(21).C(21)
      DOUBLE PRECISION DEL.PAR(21).WKAREA(50).A(21).X(21).T(21).
     *   IWF(21.21).S(21).RES.D1.D2
C
C
      READ(5.1001) M.N.REP.ISTART
C
      IF(ISTART.EQ.0) ISTART=1
      REP-REP+ISTART-1
C
      MP1-M+1
      READ(5.1002) DEL.MAX
      READ(5.1003) (PAR(I).I-1.MP1)
      READ(8.1004) ISEED
      WRITE(6.3001) M.N.REP.DEL.MAX.ISEED.(PAR(I).I-1.MP1)
C
C
      DO 100 IREP-ISTART.REP
      WRITE(11.2001) IREP.ISEED.(PAR(I).I-1.MP1)
      CALL GEN (PAR.Z.N.M.ISEED.WKAREA)
      CALL FORM (Z.N.M.F)
      WRITE(11.2004) M.N.(F(I).I-1.MP1)
C
C  INITIAL ESTIMATES
C
      CALL SPEAR (F.MP1.N.S.T.B.C)
      WRITE(11.2003) (T(I).I-1.MP1)
C
C  MINRES
C
      DO 10 I-1.MP1
      X(I)=S(I)
10    CONTINUE
      CALL MINRES (F.MP1.N.X.WKAREA.RES.DEL.MAX.ITER)
      WRITE(11.2002) ITER.(X(I).I-1.MP1)
      WRITE(11.2003) RES
C
C  GOODMX
C
      DO 20 I-1.MP1
      X(I)-T(I)
20    CONTINUE
```

```
      ITER=IREP
      CALL GOODMX (F,MP1,N,X,WKAREA,B,DEL,MAX,ITER)
      WRITE(11,2002) ITER,(X(I),I=1,MP1)
C
C  MAXLIK
C
      DO 30 I=1,MP1
      X(I)=T(I)
30    CONTINUE
      ITER=IREP
      CALL MAXLIK (F,MP1,N,X,T,INF,S,D1,D2,WKAREA,B,DEL,MAX,ITER)
      WRITE(11,2002) ITER,(X(I),I=1,MP1)
      WRITE(11,2003) (INF(I,I),I=1,MP1)
      WRITE(11,2003) D1,D2
100   CONTINUE
      WRITE(6,3002) ISEED
      WRITE(9,1004) ISEED
1001  FORMAT(4I5)
1002  FORMAT(F10.8,I10)
1003  FORMAT(16F5.3)
1004  FORMAT(I10)
2001  FORMAT(I4,1X,I10,20F4.2)
2002  FORMAT(I5,5X,6F10.6/(10X,6F10.6))
2003  FORMAT(10X,6F10.6)
2004  FORMAT(18I4)
3001  FORMAT('0',10X,'NUMBER OF ITEMS: M =',I3/
     *  11X,'NUMBER OF STUDENTS: N =',I4/
     *  11X,'NUMBER OF REPLICATIONS: R =',I4/
     *  11X,'TEST FOR CONVERGENCE: DEL =',F10.8/
     *  11X,'MAX. NO. OF ITERATIONS: MAX =',I4/
     *  11X,'INITIAL SEED NO.:  ',I10/
     *  11X,'PARAMETERS USED:   K =',F5.2/
     *  29X,'X = ',15F5.2)
3002  FORMAT(11X,'NEXT SEED NO.:  ',I10)
      RETURN
      END
      SUBROUTINE ESTIMA
      INTEGER F(232),Z(20,120),REP,MAX,B(21),C(21)
      DOUBLE PRECISION DEL,PAR(21),WKAREA(50),A(21),X(21),T(21),
     *   INF(21,21),S(21),RES,D1,D2
      INTEGER CHAR(5),FMT(4),NUM(21),TFORM(10),ID,TEMP,
     *  BLANK,INPUT(10,120),ITNO(10,20),FS(21,21),FSMT(4),KP
      DOUBLE PRECISION EST(5,21)
      DATA  FMT/'(2X,','A3, ','    ','I1) '/,KP/' K  '/
      DATA FSMT/'(70X','    ','    ','I3) '/,BLANK/'    '/
      DATA NUM/' 1  ',' 2  ',' 3  ',' 4  ',' 5  ',' 6  ',' 7  ',' 8  ',
     *  ' 9  ','10  ','11  ','12  ','13  ','14  ','15  ','16  ','17  ',
     *  '18  ','19  ','20  ','21  '/
C
C
      READ(5,1001) DEL,MAX
      WRITE(6,3001) DEL,MAX
C
C
      DO 300 IGROUP=1,1000
      READ(15,2001,END=5040) CHAR,N,NITEM,NFORM,TFORM(1),
     *  (ITNO(1,I),I=1,20)
      ID=CHAR(1)
      IF(NFORM.EQ.1) GO TO 110
      DO 105 J=2,NFORM
      READ(15,2002,END=5015) TEMP,TFORM(J),
     *  (ITNO(J,I),I=1,20)
      IF(TEMP.NE.BLANK) GO TO 5010
105   CONTINUE
110   FMT(3)=NUM(NITEM)
      DO 115 J=1,N
      READ(15,FMT,ERR=5020,END=5035) TEMP,
     *  (INPUT(I,J),I=1,NITEM)
      IF(TEMP.NE.ID) GO TO 5030
115   CONTINUE
C
C
      WRITE(6,3002)
      WRITE(6,3003) CHAR,N,NFORM
      DO 250 K=1,NFORM
      IF(NFORM.GT.1) GO TO 135
      DO 120 J=1,NITEM
      ITNO(K,J)=J
120   CONTINUE
```

```
135   DO 150 J=1,NITEM
      IF(ITNO(K,J).EQ.0) GO TO 160
      DO 140 I=1,N
      Z(J,I)=INPUT(ITNO(K,J),I)
140   CONTINUE
150   CONTINUE
      J=NITEM+1
160   M=J-1
C
C
      CALL FORM (Z,N,M,F)
      MP1=M+1
      IF(M.EQ.1) GO TO 241
C
C  INITIAL ESTIMATES
C
      CALL SPEAR (F,MP1,N,S,T,B,C)
C
C  MINRES
C
      DO 210 I=1,MP1
      EST(1,I)=T(I)
      X(I)=S(I)
210   CONTINUE
      CALL MINRES (F,MP1,N,X,WKAREA,RES,DEL,MAX,ITER)
      IMIN=ITER
C
C  GOODMX
C
      DO 220 I=1,MP1
      EST(2,I)=X(I)
      X(I)=T(I)
220   CONTINUE
      ITER=IGROUP
      CALL GOODMX (F,MP1,N,X,WKAREA,B,DEL,MAX,ITER)
      IGOOD=ITER
C
C  MAXLIK
C
      DO 230 I=1,MP1
      EST(3,I)=X(I)
      X(I)=T(I)
230   CONTINUE
```

```
      ITER=IGROUP
      CALL MAXLIK (F,MP1,N,X,T,INF,S,D1,D2,WKAREA,B,DEL,MAX,ITER)
      IMAX=ITER
      IK=0
      DO 240 I=1,MP1
      EST(4,I)=X(I)
      EST(5,I)=-INF(I,I)
      DO 240 J=1,MP1
      IK=IK+1
      FS(J,I)=F(IK)
      FS(I,J)=FS(J,I)
      IF(I.EQ.J.AND.J.GT.1) FS(I,I)=1000
240   CONTINUE
241   FSMT(3)=NUM(MP1)
      WRITE(6,3004) TFORM(K),M
      WRITE(6,FSMT)((FS(I,J),I=1,MP1),J=1,MP1)
      IF(M.EQ.1) GO TO 246
      WRITE(6,3005) KP,(EST(I,1),I=1,5)
      DO 245 I=2,MP1
      IM1=I-1
      WRITE(6,3006) NUM(ITNO(K,IM1)),(EST(J,I),J=1,5)
245   CONTINUE
      WRITE(6,3007) RES,IMIN,IGOOD,IMAX
      GO TO 250
246   WRITE(6,3008)
250   CONTINUE
300   CONTINUE
1001  FORMAT(F10.8,I10)
3001  FORMAT('0',10X,'TEST FOR CONVERGENCE: DEL =',F10.8/
     *  11X,'MAX. NO. OF ITERATIONS: MAX =',I4)
2001  FORMAT(2X,A3,A1,3A3,I5,I2,I3,A3,20I2)
2002  FORMAT(1X,A4,20X,A3,20I2)
3002  FORMAT('1',40X,'ESTIMATION OF PARAMETERS IN THE LKKWMP MODEL'//
     *  ' ',36X,'NO.  NO.      TEST   NO.',24X,'E S T I M A T E S'/
     *  ' ',12X,'ID  SCH  GRADE  DATE    OF    OF       FORM   OF',
     *  54X,'EST.'/
     *  ' ',35X,'STU  FORMS',10X,'ITEMS',11X,'SPEARMAN   MINRES',
     *  4X,'GOODMAN    MLE     VARIANCE')
```

```
3003  FORMAT(' ',11X,A3,3X,A3,3X,3(1X,A3),2(2X,I3))
3004  FORMAT('0',50X,A3,3X,I2,14X,'FREQUENCY')
3005  FORMAT('0',61X,A4,4X,5F10.6)
3006  FORMAT(' ',58X,'   ITEM ',A2,2X,5F10.6)
3007  FORMAT(' ',62X,'SS OF RESIDUAL:   ',F10.6/
     *         ' ',60X,'NO. OF ITERATIONS:  ',3I10)
3008  FORMAT('0',72X,'NO ESTIMATION FOR ONE ITEM. ')
4001  FORMAT('0',5X,'***** MISSING ITEM FORM CARD.'/
     *  ' ',5X,'***** PROGRAM TERMINATED.')
4002  FORMAT('0',5X,'***** ERROR IN READING RESPONSE DATA.'/
     *  ' ',5X,'***** PROGRAM TERMINATED.')
4003  FORMAT('0',5X,'***** MISSING RESPONSE DATA.'/
     *  ' ',5X,'***** PROGRAM TERMINATED ')
4004  FORMAT('0',5X,'***** AND END OF FILE ENCOUNTERED ON UNIT 15.')
4005  FORMAT(' ',11X,'ID READ:  ',A3)
      GO TO 5040
5010  WRITE(6,4001)
      WRITE(6,4005) TEMP
      WRITE(6,3003) CHAR,N,NFORM
      GO TO 5040
5015  WRITE(6,4001)
      WRITE(6,4004)
      WRITE(6,3003) CHAR,N,NFORM
      GO TO 5040
5020  WRITE(6,4002)
      WRITE(6,4005) TEMP
      WRITE(6,3003) CHAR,N,NFORM
      GO TO 5040
5030  WRITE(6,4003)
      WRITE(6,4005) TEMP
      WRITE(6,3003) CHAR,N,NFORM
      GO TO 5040
5035  WRITE(6,4003)
      WRITE(6,4004)
      WRITE(6,3003) CHAR,N,NFORM
5040  RETURN
      END
      SUBROUTINE GEN (X,Z,N,M,ISEED,R)
      DOUBLE PRECISION X(1),R(M)
      INTEGER Z(20,120)
C
C
C  THIS SUBPROGRAM SIMULATES THE RESPONSES OF N SUBJECTS ON M
C    ITEMS USING THE PRIMITIVE MODEL.  THE ITEM RESPONSES FOR
C    EACH STUDENT ARE ASSUMED TO BE INDEPENDENT.
C  Z(M,N) STORES THE RAW DATA:
C    1 - CORRECT
C    0 - INCORRECT
C  PARAMETERS:   X(1) - PROBABILITY OF A STUDENT BEING SLECTED
C                       BELONGED TO THE "+" GROUP.
C                X(M) - PROBABILITY OF AN INCORRECT RESPONSE ON
C                       THE ITEM GIVEN THAT THE STUDENT BELONGING
C                       TO THE "+" GROUP.
C  SUBROUTINES CALLED: GGUB, UNIFORM RANDOM NUMBER GENERATOR.
C                            THE RANDOM NUMBERS ARE STORED IN R.
C  IF R > K THEN "+" GROUP, ELSE "-" GROUP.
C    FOR "+":  IF R > X , Z=1 <==> CORRECT RESPONSE
C              IF R < X , Z=0 <==> INCORRECT RESPONSE
C    FOR "-":  Z=0 FOR ALL ITEMS.
C
C
      DO 100 I=1,N
C  TO DETERMINE GROUP MEMBERSHIP:
      CALL GGUB(ISEED,1,R)
      IF (X(1) - R(1)) 70,10,10
C  FOR THE "+" GROUP:
10    CALL GGUB(ISEED,M,R)
      DO 40 J=1,M
      Z(J,I)=0
      IF (X(J+1) .LT. R(J)) Z(J,I)=1
40    CONTINUE
      GO TO 100
C  FOR THE "-" GROUP:
70    DO 80 J=1,M
      Z(J,I)=0
80    CONTINUE
100   CONTINUE
      RETURN
      END
      SUBROUTINE GGUB(ISEED,N,R)
      DOUBLE PRECISION R(N)
      DOUBLE PRECISION Z,D2P31M,D2PN31
      DATA D2P31M/2147483647.D0/,D2PN31/Z3920000000000000/
      Z=ISEED
      DO 5 I=1,N
      Z=DMOD(16807.D0*Z,D2P31M)
    5 R(I)=Z*D2PN31
      ISEED=Z
      RETURN
      END
      SUBROUTINE FORM (Z,N,M,F)
      INTEGER Z(20,120),F(1)
      MP1=M+1
      LEN=MP1*(MP1+1)/2
      DO 10 I=1,LEN
      F(I)=0
10    CONTINUE
C  GET MARGINAL
      DO 20 J=1,M
      DO 15 I=1,N
      F(J+1)=F(J+1)+Z(J,I)
15    CONTINUE
20    CONTINUE
C  GET F(1)
      DO 30 I=1,N
      IT=1
      DO 25 J=1,M
      IT=IT*(1-Z(J,I))
25    CONTINUE
      F(1)=F(1)+IT
30    CONTINUE
C  GET JOINT
      L=MP1
      MM1=M-1
      DO 50 J1=1,MM1
      L=L+1
      J1P1=J1+1
      DO 45 J2=J1P1,M
      L=L+1
      DO 40 I=1,N
      F(L)=F(L)+Z(J1,I)*Z(J2,I)
40    CONTINUE
45    CONTINUE
50    CONTINUE
      RETURN
      END
      SUBROUTINE SPEAR (F,MP1,N,A,X,B,C)
      INTEGER F(1),B(MP1),C(MP1),SUM,SUMS,T
      DOUBLE PRECISION SQ,TK,A(MP1),X(MP1)
      L=1
      T=0
      DO 10 I=1,MP1
      SUM=0
      SUMS=0
      DO 5 J=1,MP1
      IF (J.GT.I) L=L+1
      IF (J.LE.I) L=L+MP1-J+1
      IF (J.EQ.1) L=I
      IF (J.EQ.I) GO TO 5
      SUM=SUM+F(L)
      SUMS=SUMS+F(L)*F(L)
    5 CONTINUE
      C(I)=SUM
      B(I)=SUMS
      T=T+SUM
   10 CONTINUE
      DO 20 I=1,MP1
      SQ=DFLOAT(C(I)*C(I)-B(I))/DFLOAT(T-C(I)*2)
      A(I)=DSQRT(SQ/DFLOAT(N))
      IF (I.EQ.1) TK=SQ
      IF (I.NE.1) X(I)=1.D0 - DSQRT(SQ/TK)
   20 CONTINUE
      X(1)=TK/DFLOAT(N)
      RETURN
      END
      SUBROUTINE MINRES (F,MP1,N,X,Y,RES,DEL,MAX,ITER)
      INTEGER F(1),MP1,N,MAX,ITER
      DOUBLE PRECISION X(MP1),Y(MP1),SUM,SUMS,DEL,RES
      DO 100 ITER=1,MAX
      DO 5 I=1,MP1
      Y(I)=X(I)
5     CONTINUE
      L=1
      DO 20 I=1,MP1
      SUM=0.0D0
      SUMS=0.0D0
      DO 15 J=1,MP1
      IF (J.GT.I) L=L+1
      IF (J.LE.I) L=L+MP1-J+1
      IF (J.EQ.1) L=I
      IF (J.EQ.I) GO TO 15
      SUM=SUM+DFLOAT(F(L))*X(J)
      SUMS=SUMS+X(J)*X(J)
15    CONTINUE
      X(I)=SUM/(DFLOAT(N)*SUMS)
20    CONTINUE
      DO 25 I=1,MP1
      IF(DABS(X(I)-Y(I)).GT.DEL) GO TO 100
25    CONTINUE
      GO TO 200
100   CONTINUE
      ITER=MAX+1
200   CONTINUE
      L=1
      RES=0.0D0
      DO 215 I=1,MP1
      DO 210 J=1,MP1
      IF (J.GT.I) L=L+1
      IF (J.LE.I) L=L+MP1-J+1
      IF (J.EQ.1) L=I
      IF (J.EQ.I) GO TO 215
      RES=RES+(DFLOAT(F(L))/DFLOAT(N)-X(I)*X(J))**2
210   CONTINUE
215   CONTINUE
      DO 220 I=2,MP1
      X(I)=1.0D0-X(I)/X(1)
220   CONTINUE
      X(1)=X(1)*X(1)
      RETURN
      END
      SUBROUTINE GOODMX (F,MP1,N,X,Y,B,DEL,MAX,ITER)
      INTEGER F(MP1),B(MP1),MAX,ITER,N
      DOUBLE PRECISION X(MP1),Y(MP1),P,DEL
      IREP=ITER
      DO 1 I=1,MP1
      B(I)=0
 1    CONTINUE
      IFLAG=1
      DO 100 ITER=1,MAX
      CALL MAXFIX (B,MP1,X,IFLAG,DEL)
      IF(IFLAG-2) 9,9,3
 3    IF(ITER.EQ.1) GO TO 9
      WRITE(16,2002)
      DO 4 I=1,MP1
      X(I)=9.0909D0
 4    CONTINUE
      GO TO 300
 9    P=1.0D0
      DO 10 I=1,MP1
      Y(I)=X(I)
 10   CONTINUE
      DO 11 I=2,MP1
      P=P*X(I)
      IF(P.LT.1.0D-65) GO TO 12
 11   CONTINUE
      GO TO 15
 12   P=1.0D-65
 15   X(1)=DFLOAT(N-F(1))/DFLOAT(N)
     *     +DFLOAT(F(1))*P*X(1)/(DFLOAT(N)*(1.0D0-X(1))
     *                               +DFLOAT(N)*P*X(1))
      DO 20 I=2,MP1
      X(I)=1.0D0-DFLOAT(F(I))/(DFLOAT(N)*X(1))
 20   CONTINUE
      DO 30 I=1,MP1
      IF (DABS(Y(I)-X(I)).GT.DEL) GO TO 100
 30   CONTINUE
      GO TO 200
 100  CONTINUE
      ITER=MAX+1
 200  CONTINUE
      IF(IFLAG.EQ.1) GO TO 400
 300  WRITE(16,2000) IREP,ITER,B
      WRITE(16,2001) (X(IPARM),IPARM=1,MP1)
 2000 FORMAT(' GOODMX -- REP: ',I4,' ITER: ',I4,' INDEX: ',
     *  I3,3(1X,5I1))
 2001 FORMAT(14X,6F15.7,(/31X,5F15.7))
 2002 FORMAT(' GOODMX -- ALL ESTIMATORS ARE FIXED, RETURN',
     *  ' TO MAIN PROGRAM ')
 400  RETURN
      END
      SUBROUTINE MAXLIK (F,MP1,N,X,Y,INF,S,D1,D2,WKAREA,B,DEL,MAX,ITER)
      INTEGER F(MP1),B(MP1),ITER,I,J,II,I1,I2,MAX,M,N
      DOUBLE PRECISION INF(21,21),X(MP1),Y(MP1),S(MP1),DEL,D1,D2,
     *   RFIX,P,Q,R,RR,WKAREA(40)
      M=MP1-1
      IREP=ITER
      DO 1 I=1,MP1
      B(I)=0
      Y(I)=0.0D0
      S(I)=0.0D0
1     CONTINUE
      IFLAG=1
      DO 100 ITER=1,MAX
      DO 2 I=1,MP1
      Y(I)=S(I)
2     CONTINUE
      CALL MAXFIX (B,MP1,X,IFLAG,DEL)
      IF(IFLAG-2) 9,9,3
3     IF(ITER.EQ.1) GO TO 9
      WRITE(6,2002)
      DO 4 I=1,MP1
      X(I)=9.0909D0
      DO 4 II=1,MP1
      INF(I,II)=9.0909D0
4     CONTINUE
      GO TO 300
9     P=1.0D0
      DO 10 I = 2,MP1
      P=P*X(I)
      IF(P.LT.1.0D-65) GO TO 12
10    CONTINUE
      GO TO 13
12    P=1.0D-65
13    Q=1.0D0-P
      R=P/(1.0D0-X(1)*Q)
      RR=Q/(1.0D0-X(1)*Q)
      S(1)=DFLOAT(N-F(1))/X(1)-DFLOAT(F(1))*RR
      INF(1,1)=-DFLOAT(N-F(1))/X(1)**2
     *   -DFLOAT(F(1))*RR*RR
```

```
      DO 15 I1 = 2,MP1
      B(I1)=DFLOAT(N-F(1))/X(I1)
     *    -DFLOAT(F(I1))/(X(I1)*(1-X(I1)))
     *    +DFLOAT(F(1))*P/X(I1)/(1.0D0-X(1)*Q)*X(1)
      INF(1,I1)=DFLOAT(F(1))*P/X(I1)/(1.0D0-X(1)*Q)/(1.0D0-X(1)*Q)
      INF(I1,1)=INF(1,I1)
      RFIX=0.0D0
      IF(R.GE.1.0D-36)
     *    RFIX=DFLOAT(F(1))*P/X(I1)/X(I1)/(1.0D0-X(1)*Q)
     *         /(1.0D0-X(1)*Q)*P*X(1)*X(1)
      INF(I1,I1)=-DFLOAT(N-F(1))/X(I1)**2
     *    +DFLOAT(F(I1))*(1-X(I1)*2)/(X(I1)*(1-X(I1)))**2
     *    -RFIX
15    CONTINUE
      DO 25 I = 2,M
      I1=I+1
      DO 20 I2= I1,MP1
      INF(I,I2)=DFLOAT(F(1))*P/X(I)/X(I2)
     *          /(1.0D0-X(1)*Q)/(1.0D0-X(1)*Q)*(1.0D0-X(1))*X(1)
      INF(I2,I)=INF(I,I2)
20    CONTINUE
25    CONTINUE
C  SOLVE FOR THE INCREMENTS
      D1=1.0D0
      CALL LINV3F (INF,B,3,MP1,21,D1,D2,WKAREA,IER)
      DO 30 I=1,MP1
      X(I)=X(I)-B(I)
30    CONTINUE
      DO 35 I=1,MP1
      IF(DABS(Y(I)-B(I)).GT.DEL) GO TO 100
35    CONTINUE
      GO TO 200
100   CONTINUE
      ITER=MAX+1
200   CONTINUE
      IF (IFLAG.EQ.1) GO TO 400
      CALL MAXFIX (B,MP1,X,IFLAG,DEL)
300   WRITE(16,2000) IREP,ITER,B
      WRITE(16,2001) (X(IPARM),IPARM=1,MP1)
      WRITE(16,2001) (B(IPARM),IPARM=1,MP1)
2000  FORMAT(' MAXLIK -- REP: ',I4,' ITER: ',I4,' INDEX: ',
     *  I3,3(1X,5I1))
2001  FORMAT(16X,6F15.7,(/31X,5F15.7))
2002  FORMAT(' MAXLIK -- ALL ESTIMATORS ARE FIXED, RETURN',
     *  ' TO MAIN PROGRAM.')
400   RETURN
      END
      SUBROUTINE MAXFIX (B,MP1,X,IFLAG,DEL)
      INTEGER B(MP1),BTOTAL
      DOUBLE PRECISION X(MP1),DEL,BOUNDL,BOUNDU
      BTOTAL=0
      BOUNDL=DEL*1.0D-1
      BOUNDU=1.D0 - BOUNDL
      IF (IFLAG.EQ.1) GO TO 100
      DO 9 I=1,MP1
      IF (X(I).LE.BOUNDL) GO TO 3
      IF (X(I).GE.BOUNDU) GO TO 5
      GO TO 9
3     B(I)=1
      GO TO 7
5     B(I)=2
7     IF(B(I).EQ.1) X(I)=BOUNDL
      IF(B(I).EQ.2) X(I)=BOUNDU
9     CONTINUE
      GO TO 200
100   DO 110 I=1,MP1
      IF (X(I).LE.BOUNDL) GO TO 103
      IF (X(I).GE.BOUNDU) GO TO 105
      GO TO 109
103   B(I)=1
      GO TO 107
105   B(I)=2
107   IF(B(I).EQ.1) X(I)=0.5D0
      IF(B(I).EQ.2) X(I)=0.5D0
109   BTOTAL=BTOTAL+B(I)
110   CONTINUE
      IF (BTOTAL.NE.0) IFLAG=2
200   DO 150 I=1,MP1
      IF(B(I).EQ.0) GO TO 300
150   CONTINUE
      IFLAG=3
300   RETURN
      END
```

APPENDIX III

Summaries of the Monte Carlo Study
by Combinations of the Parameters k and x_t's,
Sample Size (n) and Number of Items (m)

```
                                        TABLE A3.1

                                  ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10      # SET  1     K=0.30
                                        ---                    --             --     ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29864 .15880 .19697 .22548 .18840 .20191 .19188 .20096 .20129 .22442 .20910 .       .       .       .       .
STD       .10032 .15429 .18135 .17947 .19136 .19296 .16147 .16278 .20727 .18521 .17213 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.84), S.S. RESIDUAL:.01209(SD:.00695))
MEAN      .29826 .15855 .19668 .22411 .18711 .20114 .19227 .20010 .20048 .22307 .20795 .       .       .       .       .
STD       .10013 .15345 .18054 .17770 .19035 .19213 .15947 .16068 .20561 .18402 .16955 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.42))
MEAN      .29850 .15998 .20072 .22425 .18649 .20419 .19226 .20046 .20004 .22307 .20914 .       .       .       .       .
STD       .10011 .15330 .18070 .17602 .19033 .19338 .15957 .15845 .20363 .18290 .16702 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.40))
MEAN      .29850 .15997 .20072 .22425 .18649 .20419 .19226 .20046 .20004 .22306 .20914 .       .       .       .       .
STD       .10012 .15330 .18070 .17602 .19033 .19338 .15956 .15845 .20362 .18290 .16702 .       .       .       .       .


                                        TABLE A3.2

                                  ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10      # SET  2     K=0.30
                                        ---                    --             --     ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29919 .38173 .38560 .39862 .40919 .42692 .37254 .37106 .41000 .38901 .44169 .       .       .       .       .
STD       .09638 .21451 .20423 .23652 .25791 .22334 .22603 .23276 .23501 .22210 .20376 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 1.19), S.S. RESIDUAL:.02609(SD:.01360))
MEAN      .29179 .37620 .38054 .39307 .40238 .42107 .36918 .36512 .40594 .38174 .43561 .       .       .       .       .
STD       .09686 .21246 .20573 .23273 .25584 .22338 .22909 .23144 .23165 .22017 .20227 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.1(SD: 0.36))
MEAN      .29251 .37815 .38407 .39501 .39940 .41584 .37636 .36890 .40621 .38060 .41760 .       .       .       .       .
STD       .09519 .20314 .20987 .22953 .24711 .21793 .22541 .23132 .22157 .22230 .19987 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.67))
MEAN      .29251 .37877 .38398 .39493 .39937 .41583 .37639 .36094 .40621 .38063 .41757 .       .       .       .       .
STD       .09516 .20313 .20988 .22952 .24717 .21797 .22540 .23130 .22355 .22231 .19992 .       .       .       .       .
```

```
                                              TABLE A3.3

                                   ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    # SET  3    R=0.30
                                         ---                   --         --      ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ------------------------------------------------------------------------------------------------------------------------
VALUES     0.30    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50     .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .30229 .48366 .50193 .49770 .49805 .46719 .52679 .52511 .50529 .51091 .52036 .      .      .      .      .
STD        .09096 .21661 .22011 .24000 .21881 .21151 .22269 .22072 .21054 .25236 .20655 .      .      .      .      .
           ------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.86), S.S. RESIDUAL:.03066(SD:.01468))
MEAN       .29609 .47935 .49008 .48061 .48083 .45920 .51656 .51642 .49626 .51309 .51012 .      .      .      .      .
STD        .09063 .23400 .23498 .24576 .21777 .20932 .22064 .22005 .21465 .25112 .20492 .      .      .      .      .
           ------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.67))
MEAN       .30334 .49662 .49548 .49426 .50081 .47409 .51140 .52516 .50559 .52231 .52091 .      .      .      .      .
STD        .09102 .23315 .21072 .23662 .20090 .20222 .21195 .21914 .20290 .23982 .20015 .      .      .      .      .
           ------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.9(SD: 0.80))
MEAN       .30320 .4965[illegible] .49531 .49423 .49992 .47382 .51130 .52510 .50551 .52215 .52064 .      .      .      .      .
STD        .09114 .23318 .21072 .23667 .20874 .20223 .21176 .21928 .20307 .23974 .20036 .      .      .      .      .


                                              TABLE A3.4

                                   ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    # SET  4    R=0.30
                                         ---                   --         --      ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ------------------------------------------------------------------------------------------------------------------------
VALUES     0.30    0.10    0.15    0.20    0.25    0.30    0.40    0.50    0.70    0.80    0.85     .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .32117 .12750 .16639 .17991 .26830 .30129 .39970 .49922 .72542 .78477 .82213 .      .      .      .      .
STD        .11106 .16332 .16017 .16988 .20543 .23689 .22937 .23963 .20940 .18038 .17279 .      .      .      .      .
           ------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 1.13), S.S. RESIDUAL:.01674(SD:.00952))
MEAN       .31945 .12508 .16116 .17361 .26407 .29857 .39619 .49146 .72226 .78069 .82033 .      .      .      .      .
STD        .11038 .16030 .15255 .16740 .20412 .23081 .22903 .23520 .21053 .17973 .17216 .      .      .      .      .
           ------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.20))
MEAN       .32051 .12625 .16253 .17671 .27155 .30031 .39021 .49059 .72457 .78124 .82102 .      .      .      .      .
STD        .11104 .15971 .14939 .16673 .20720 .22302 .22640 .23210 .20959 .17348 .17095 .      .      .      .      .
           ------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.61))
MEAN       .32046 .12620 .16245 .17663 .27146 .30021 .39016 .49048 .72453 .78122 .82099 .      .      .      .      .
STD        .11101 .15958 .14933 .16666 .20727 .22302 .22638 .23219 .20960 .17741 .17098 .      .      .      .      .
```

```
                                        TABLE A3.5

                                ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    I SET  5    G=0.30
                                    ---                   --           --      ----

PARAMETER  G      S      S      S      S      S      S      S      S      S      S      S      S      S      S      S
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29253 .30257 .25504 .39248 .10630 .10073 .04380 .49117 .26327 .15100 .40000 .      .      .      .      .
STD       .10767 .24142 .21505 .21905 .10960 .13519 .10410 .26098 .21473 .14471 .23071 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.83), S.S. RESIDUAL:.01420(SD:.00060))
MEAN      .29100 .30416 .25397 .38764 .10640 .10061 .04260 .48955 .26097 .15150 .43551 .      .      .      .      .
STD       .10769 .23901 .21290 .21686 .10897 .13423 .09919 .26015 .21223 .14363 .23724 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.22))
MEAN      .29250 .30380 .25728 .38762 .10898 .11161 .04141 .48901 .26438 .15224 .47284 .      .      .      .      .
STD       .10787 .21629 .21238 .21370 .10674 .13776 .09434 .25791 .21079 .14355 .23539 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.47))
MEAN      .29250 .30380 .25727 .38762 .10898 .11161 .04140 .48901 .26438 .15224 .47284 .      .      .      .      .
STD       .10787 .21629 .21238 .21370 .10674 .13776 .09438 .25791 .21079 .14355 .23539 .      .      .      .      .


                                        TABLE A3.6

                                ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    I SET  6    G=0.30
                                    ---                   --           --      ----

PARAMETER  G      S      S      S      S      S      S      S      S      S      S      S      S      S      S      S
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29837 .63258 .75644 .60992 .77015 .90035 .94010 .50790 .70416 .82229 .57126 .      .      .      .      .
STD       .11777 .24923 .22700 .26628 .19091 .15605 .10404 .25255 .22925 .18121 .24615 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP:  95, AVE # OF ITERATIONS 9.9(SD: 2.90), S.S. RESIDUAL:.01418(SD:.00031))
MEAN      .27722 .59272 .73327 .57812 .74504 .90157 .93433 .45770 .66368 .80100 .52979 .      .      .      .      .
STD       .11370 .25166 .23466 .26520 .20604 .15419 .11044 .20514 .22096 .19027 .22094 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  97, AVE # OF ITERATIONS: 7.5(SD: 1.73))
MEAN      .29416 .61803 .75250 .59449 .76013 .91030 .93995 .48477 .70606 .81921 .56693 .      .      .      .      .
STD       .10644 .22963 .20953 .25168 .18048 .13296 .10007 .22692 .20967 .16412 .22114 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  50, AVE # OF ITERATIONS: 9.6(SD: 3.52))
MEAN      .23486 .57806 .71163 .50091 .74327 .88477 .92169 .45837 .68199 .80807 .52479 .      .      .      .      .
STD       .12724 .25144 .21619 .24540 .16463 .13790 .09835 .21156 .21974 .18170 .21908 .      .      .      .      .
```

TABLE A3.7

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 B SET 7 A=0.30

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
(SPEARMAN, # OF REP: 100)																
MEAN	.30555	.17060	.20614	.17703	.19491	.19910	.18619	.20090	.21014	.20201	.17335	.20405	.20493	.20113	.19024	.20627
STD	.10352	.15516	.18746	.16792	.19154	.17053	.15055	.16551	.17101	.17596	.15761	.20491	.18074	.18040	.17372	.17049
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.2(SD: 0.82), S.S. RESIDUAL:.02992(SD:.01567))																
MEAN	.30526	.17054	.20591	.17737	.19707	.19853	.18546	.20082	.20904	.20170	.17020	.20375	.20363	.20021	.19047	.20514
STD	.10343	.15026	.18745	.16717	.19173	.17004	.14981	.16550	.17048	.17453	.15600	.20393	.18017	.18761	.17342	.16872
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.36))																
MEAN	.30550	.17295	.20010	.17790	.19425	.19925	.18271	.20300	.20932	.20104	.17113	.20201	.20297	.19956	.19356	.20657
STD	.10345	.15170	.18935	.16456	.18079	.17127	.14502	.16579	.17091	.17299	.15766	.20199	.18355	.18602	.17456	.16699
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.30))																
MEAN	.30550	.17295	.20010	.17790	.19425	.19925	.18271	.20300	.20932	.20104	.17113	.20201	.20297	.19956	.19356	.20657
STD	.10345	.151[illegible]	.18935	.16456	.18079	.17127	.14502	.16579	.17091	.17299	.15766	.20199	.18355	.18602	.17456	.16699

TABLE A3.8

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 B SET 8 A=0.30

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.30	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
(SPEARMAN, # OF REP: 100)																
MEAN	.29047	.40268	.42556	.39670	.39497	.40625	.43004	.42029	.41374	.41091	.40050	.42104	.39417	.41976	.38546	.40059
STD	.11308	.21292	.22051	.25060	.24362	.22310	.22112	.23937	.20932	.24490	.25714	.21405	.24369	.22616	.20045	.23150
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 1.02), S.S. RESIDUAL:.06320(SD:.03150))																
MEAN	.28850	.40025	.42027	.39212	.39170	.40145	.42671	.42450	.40796	.40508	.39531	.41500	.38960	.41532	.38102	.39746
STD	.11376	.21103	.22521	.24906	.24201	.22177	.22072	.23813	.20334	.24309	.25440	.21275	.24261	.22536	.19350	.23009
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.5(SD: 0.50))																
MEAN	.28950	.40471	.42334	.39151	.38893	.40231	.42709	.42713	.41023	.41064	.40272	.41330	.38956	.41404	.38013	.39952
STD	.11110	.20325	.22138	.24631	.23510	.22147	.21690	.23279	.20399	.24579	.25010	.20220	.23006	.22127	.19866	.23075
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.51))																
MEAN	.28950	.40470	.42334	.39151	.38893	.40231	.42709	.42713	.41023	.41064	.40272	.41330	.38956	.41404	.38013	.39952
STD	.11110	.20325	.22138	.24631	.23510	.22147	.21690	.23279	.20399	.24579	.25010	.20220	.23006	.22127	.19866	.23075

```
                                   TABLE A3.9

                          ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET  9    A=0.30
                               ---                   --          --    ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .27600 .51972 .49667 .46290 .48029 .47353 .50896 .55350 .51874 .46400 .53590 .46152 .45676 .55626 .50346 .52999
STD       .10059 .23109 .23146 .21145 .23022 .22323 .21960 .23127 .22016 .21999 .21922 .25524 .22902 .22441 .22352 .23001
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.65), S.S. RESIDUAL:.06467(SD:.01003))
MEAN      .27267 .51293 .49270 .45411 .48395 .46820 .50416 .54055 .51365 .46096 .52663 .45746 .44908 .54035 .50049 .52406
STD       .10002 .23390 .23193 .22991 .22722 .21902 .21705 .22970 .22005 .21739 .21590 .25506 .22951 .22752 .22494 .22842
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.42))
MEAN      .27701 .51263 .49712 .46132 .49053 .47657 .50598 .54543 .52125 .46992 .53013 .46309 .46138 .54848 .50991 .53016
STD       .10111 .23054 .22055 .22253 .22252 .20742 .23140 .22499 .21438 .20932 .21242 .25307 .22711 .22438 .22404 .22460
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.6(SD: 0.61))
MEAN      .27701 .51264 .49711 .46132 .49053 .47657 .50598 .54543 .52125 .46991 .53013 .46309 .46138 .54848 .50990 .53017
STD       .10111 .23053 .22055 .22253 .22253 .20741 .23148 .22499 .21439 .20932 .21242 .25308 .22712 .22437 .22404 .22459


                                   TABLE A3.10

                          ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET 10    A=0.30
                               ---                   --          --    ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.60   0.80   0.85
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29605 .08569 .15969 .18566 .28078 .30488 .38507 .37229 .45945 .53315 .54883 .60967 .67228 .60796 .81723 .86443
STD       .10350 .12758 .17904 .17257 .19511 .23709 .23962 .23428 .26209 .20271 .21661 .25034 .13919 .21754 .15569 .16735
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.55), S.S. RESIDUAL:.04467(SD:.01071))
MEAN      .29405 .08161 .15853 .18307 .27659 .30266 .37948 .36846 .45402 .52928 .54563 .60525 .66599 .60473 .81395 .86265
STD       .10303 .12356 .17965 .16938 .19099 .23524 .21731 .23170 .26450 .24152 .21669 .24540 .17992 .21574 .15749 .16850
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.7(SD: 0.45))
MEAN      .29550 .08443 .16250 .18167 .27802 .30809 .38304 .37163 .45462 .53376 .55061 .60420 .66502 .60279 .81537 .86176
STD       .10325 .12106 .18320 .16711 .19011 .23011 .23109 .22050 .25710 .23578 .21386 .24030 .17510 .21520 .15635 .16644
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.51))
MEAN      .29550 .08443 .16257 .18167 .27802 .30809 .38303 .37163 .45462 .53376 .55061 .60420 .66502 .60279 .81537 .86176
STD       .10325 .12106 .18320 .16711 .19011 .23031 .23109 .22050 .25710 .23578 .21386 .24030 .17510 .21520 .15635 .16644
```

```
                                        TABLE A3.11

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET 11    A=0.30
                                     ---                   --          --      ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30100 .10100 .16610 .20416 .24775 .32405 .32075 .38359 .44009 .51220 .05306 .14922 .25536 .36800 .44790 .24827
STD       .10400 .11490 .14270 .20066 .20960 .20402 .20917 .21244 .21200 .23527 .10010 .11795 .19044 .23752 .25400 .16179
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.72), S.S. RESIDUAL:.03046(SD:.02032))
MEAN      .30078 .10089 .16590 .20316 .24659 .32200 .32054 .38170 .43609 .51103 .05231 .14109 .25400 .36720 .44631 .24000
STD       .10500 .11463 .14275 .19846 .20018 .20215 .20816 .21030 .21269 .23372 .09872 .13523 .19085 .21601 .25051 .16061
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.45))
MEAN      .30108 .10306 .16670 .20104 .24690 .32170 .32442 .38245 .43519 .51422 .05217 .14297 .25597 .36766 .44498 .24009
STD       .10492 .11693 .14319 .19700 .20694 .19881 .21034 .20798 .21472 .23203 .09744 .13698 .20145 .23550 .24578 .15963
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.40))
MEAN      .30108 .10306 .16670 .20104 .24690 .32170 .32442 .38245 .43519 .51422 .05217 .14297 .25597 .36766 .44498 .24009
STD       .10492 .11693 .14319 .19700 .20694 .19881 .21034 .20798 .21472 .23203 .09744 .13698 .20145 .23559 .24578 .15963


                                        TABLE A3.12

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET 12    A=0.30
                                     ---                   --          --      ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29804 .90163 .86103 .82129 .71504 .71052 .60974 .58280 .52533 .51120 .95432 .89250 .75690 .65001 .53099 .76307
STD       .10604 .12710 .14017 .19173 .21773 .20962 .20890 .22934 .24110 .22139 .09139 .13915 .19797 .21556 .24113 .20731
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP:  99, AVE # OF ITERATIONS 8.2(SD: 1.20), S.S. RESIDUAL:.03700(SD:.02103))
MEAN      .28573 .89576 .85744 .81057 .69995 .69995 .66021 .55943 .50300 .51318 .95050 .88796 .73781 .63617 .50016 .74694
STD       .10594 .11236 .14713 .19558 .21050 .21508 .21471 .22075 .21394 .21979 .09669 .14402 .20642 .21973 .23555 .21540
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  99, AVE # OF ITERATIONS: 4.6(SD: 1.23))
MEAN      .29134 .89347 .85677 .81566 .71149 .69975 .67204 .56520 .51652 .52448 .95010 .88244 .74561 .64001 .50917 .75572
STD       .10058 .11369 .14040 .18272 .20356 .20292 .19597 .20735 .21469 .21043 .09261 .15188 .19419 .20460 .21879 .19781
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  85, AVE # OF ITERATIONS: 7.4(SD: 2.20))
MEAN      .30337 .88891 .84617 .80220 .71490 .68393 .67084 .54606 .51064 .50797 .94803 .87004 .72990 .62505 .51069 .74107
STD       .10649 .13686 .14120 .18363 .19220 .19301 .18310 .20192 .22419 .19944 .09300 .15433 .19510 .20370 .22413 .19661
```

```
                                        TABLE A3.13

                                  ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    B SET  1    A=0.50
                                        ---                   --         --     ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49965 .21981 .21401 .21156 .21005 .21651 .19051 .18785 .21710 .18206 .18222 .         .       .       .       .
STD       .10973 .11793 .14268 .12607 .11250 .14149 .13812 .11444 .13668 .13276 .11951 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.69), S.S. RESIDUAL:.02250(SD:.01093))
MEAN      .49629 .21081 .21245 .21133 .20943 .21603 .19037 .18749 .23620 .18220 .18212 .         .       .       .       .
STD       .10965 .13723 .14181 .12503 .13223 .14003 .13795 .11354 .13622 .13219 .11895 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.49))
MEAN      .49550 .21709 .21155 .21469 .21343 .21504 .19647 .18800 .23900 .18278 .18340 .         .       .       .       .
STD       .11012 .13695 .13952 .12721 .13379 .13823 .14006 .11113 .13359 .13000 .11879 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.40))
MEAN      .49558 .21709 .21155 .21469 .21343 .21504 .19647 .18800 .23900 .18278 .18340 .         .       .       .       .
STD       .11012 .13695 .13952 .12721 .13379 .13823 .14006 .11113 .13359 .13000 .11879 .         .       .       .       .


                                        TABLE A3.14

                                  ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    B SET  2    A=0.50
                                        ---                   --         --     ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51258 .39941 .40004 .40745 .37096 .40191 .42296 .40600 .38418 .37538 .37945 .         .       .       .       .
STD       .11418 .17092 .16213 .16002 .17207 .15773 .16829 .15535 .15188 .15580 .15068 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.62), S.S. RESIDUAL:.04999(SD:.01090))
MEAN      .50035 .39450 .40553 .40574 .37296 .39951 .41831 .40293 .38056 .37245 .37355 .         .       .       .       .
STD       .11345 .16900 .16067 .16011 .16934 .15606 .16657 .15316 .15166 .15431 .15911 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.32))
MEAN      .51355 .39651 .41265 .40080 .38232 .40303 .42192 .41049 .38538 .37891 .37719 .         .       .       .       .
STD       .11098 .16155 .15746 .15180 .16455 .14696 .15656 .15313 .14714 .15059 .15320 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.40))
MEAN      .51354 .39649 .41263 .40087 .38270 .40301 .42391 .41043 .38528 .37809 .37712 .         .       .       .       .
STD       .11100 .16155 .15746 .15179 .16455 .14697 .15655 .15312 .14717 .15060 .15320 .         .       .       .       .
```

```
                                    TABLE A3.15

                              ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     B SET  3     A=0.50
                                 ---                    --            --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50229 .50317 .51005 .51463 .49562 .48626 .48752 .49549 .51134 .50544 .53207 .      .      .      .      .
STD       .11315 .17607 .16472 .17714 .17618 .17602 .16234 .15771 .17472 .15062 .17964 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.5(SD: 0.63)), S.S. RESIDUAL:.04994(SD:.01717))
MEAN      .49529 .49092 .50634 .50850 .48913 .47727 .48225 .48600 .50409 .49809 .52592 .      .      .      .      .
STD       .11378 .17705 .16259 .17624 .17556 .17337 .15069 .15750 .17733 .15738 .17897 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.76))
MEAN      .50518 .51298 .51594 .50906 .49720 .48139 .48966 .49557 .50875 .50813 .53183 .      .      .      .      .
STD       .11401 .17093 .15448 .17107 .17474 .16412 .15256 .15714 .17231 .15093 .17265 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.51))
MEAN      .50518 .51298 .51593 .50906 .49720 .48128 .48965 .49556 .50874 .50812 .53182 .      .      .      .      .
STD       .11402 .17093 .15448 .17107 .17474 .16412 .15256 .15714 .17230 .15095 .17266 .      .      .      .      .


                                    TABLE A3.16

                              ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     B SET  4     A=0.50
                                 ---                    --            --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51451 .10902 .15722 .22697 .25607 .31055 .36154 .52556 .72233 .80797 .85424 .      .      .      .      .
STD       .10123 .09695 .11571 .13218 .13499 .15306 .15271 .18189 .14752 .12046 .10515 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.54)), S.S. RESIDUAL:.02859(SD:.01331))
MEAN      .51143 .10543 .15572 .22437 .25348 .30503 .35702 .52297 .71955 .80988 .85160 .      .      .      .      .
STD       .10282 .09450 .11437 .12945 .11363 .14849 .14988 .18057 .14690 .12018 .10522 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.36))
MEAN      .51402 .10874 .16048 .22805 .25563 .30487 .35924 .52932 .71658 .80227 .85144 .      .      .      .      .
STD       .10181 .09488 .11199 .12738 .11886 .14440 .14789 .17361 .14460 .11948 .10424 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 0.65))
MEAN      .51394 .10871 .16038 .22791 .25553 .30470 .35914 .52927 .71653 .80224 .85142 .      .      .      .      .
STD       .10181 .09488 .11188 .12737 .11888 .14443 .14787 .17350 .14462 .11450 .10425 .      .      .      .      .
```

```
                                        TABLE A3.17

                                  ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     # SET  5     A=0.50
                                        ---                    --          --       ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.50   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45   .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51023 .33790 .25160 .39140 .19817 .10168 .04100 .50046 .31000 .16357 .46474 .      .      .      .      .
STD       .10084 .14952 .14025 .16175 .12061 .09593 .06446 .17619 [illegible] .12146 .17420 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.1(SD: 0.62), S.S. RESIDUAL:.02911(SD:.01149))
MEAN      .50969 .33674 .25126 .39046 .19829 .10068 .04219 .50056 .30031 .16271 .46355 .      .      .      .      .
STD       .10853 .14607 .14003 .16179 .12035 .09380 .06240 .17460 .14416 .11994 .17320 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.34))
MEAN      .51050 .33966 .25514 .38964 .19828 .09910 .04191 .51102 .30792 .16307 .46465 .      .      .      .      .
STD       .10901 .14204 .14166 .16495 .13040 .09094 .06017 .17010 .14424 .11705 .16909 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.99))
MEAN      .51049 .33966 .25514 .38963 .19827 .09910 .04191 .51102 .30741 .16307 .46464 .      .      .      .      .
STD       .10901 .14204 .14166 .16495 .13040 .09094 .06017 .17010 .14424 .11704 .16909 .      .      .      .      .
```

```
                                        TABLE A3.18

                                  ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     # SET  6     A=0.50
                                        ---                    --          --       ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.50   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55   .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51175 .66790 .75982 .57668 .82902 .90486 .94739 .52565 .73556 .86192 .53770 .      .      .      .      .
STD       .11370 .16463 .13170 .16911 .12927 .10607 .07674 .16558 .14515 .10750 .19432 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP:  97, AVE # OF ITERATIONS 9.0(SD: 2.20), S.S. RESIDUAL:.02790(SD:.01026))
MEAN      .49240 .65010 .74559 .55291 .81594 .89638 .94100 .49197 .72500 .85077 .53123 .      .      .      .      .
STD       .11350 .15260 .12171 .16615 .13319 .10934 .07951 .16302 .14683 .10619 .18746 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  99, AVE # OF ITERATIONS: 8.4(SD: 2.02))
MEAN      .50445 .65399 .74929 .56457 .82100 .90028 .94654 .49024 .72298 .85094 .53002 .      .      .      .      .
STD       .11295 .14068 .11540 .15921 .13075 .10591 .07379 .15416 .13912 .09941 .18092 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  59, AVE # OF ITERATIONS: 8.7(SD: 3.00))
MEAN      .46961 .64007 .74468 .54015 .78734 .86201 .91636 .46210 .70956 [illegible] .51663 .      .      .      .      .
STD       .16096 .13401 .11902 .16193 .12425 .15734 .14270 .10562 .14943 .09490 [illegible] .      .      .      .      .
```

```
                                        TABLE A3.19

                                  ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15     A SET  7     B=0.50
                                      ---                    --            --    -----

PARAMETER  B      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES   0.50   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51441 .20304 .18878 .19267 .20492 .20965 .19729 .21015 .19930 .22047 .18130 .20760 .23020 .17175 .21016 .20145
STD       .11547 .13154 .12273 .12191 .13670 .12765 .14165 .12242 .13331 .14131 .13209 .12604 .11720 .11615 .13617 .14414
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.1(SD: 0.51), S.S. RESIDUALS:.05565(SD:.01984))
MEAN      .51409 .20310 .18799 .19260 .20730 .20062 .19931 .20949 .19890 .22003 .18300 .20763 .23032 .17150 .20905 .20001
STD       .11536 .13115 .12230 .12347 .13593 .12715 .14190 .12223 .13219 .14037 .13207 .12696 .11701 .11609 .13504 .14419
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .51450 .20565 .18770 .19224 .20573 .20601 .19930 .20092 .19937 .21997 .18105 .20011 .23346 .17349 .21179 .20242
STD       .11532 .13051 .12120 .12191 .13359 .12439 .14328 .12129 .13294 .13751 .13226 .12015 .11035 .11503 .13600 .14367
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.35))
MEAN      .51450 .20565 .18770 .19224 .20573 .20601 .19930 .20092 .19937 .21997 .18105 .20011 .23346 .17349 .21179 .20242
STD       .11532 .13051 .12120 .12191 .13359 .12439 .14328 .12129 .13294 .13751 .13226 .12015 .11035 .11503 .13600 .14367


                                        TABLE A3.20

                                  ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15     A SET  8     B=0.50
                                      ---                    --            --    -----

PARAMETER  B      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES   0.50   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50247 .38229 .39413 .39997 .41257 .41200 .39216 .40520 .40070 .39805 .39930 .41509 .43471 .41706 .41015 .39701
STD       .11576 .16980 .16256 .16040 .14895 .16203 .17458 .15949 .17464 .14077 .18120 .14004 .17230 .14679 .16133 .13115
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.62), S.S. RESIDUALS:.12366(SD:.03936))
MEAN      .50013 .37941 .39102 .39419 .41005 .40994 .39054 .40192 .40599 .39631 .39710 .41205 .43227 .41669 .41937 .39460
STD       .11544 .17000 .16093 .15925 .14700 .16020 .17300 .15993 .17001 .13093 .17993 .13771 .17194 .14449 .16005 .12069
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.35))
MEAN      .50250 .38350 .39026 .40107 .41159 .41075 .39365 .40345 .40501 .39765 .39990 .41556 .43700 .41660 .41012 .39567
STD       .11511 .16416 .15716 .15602 .14750 .15721 .16951 .15925 .17165 .13631 .17332 .11356 .17207 .13802 .16302 .12456
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.17))
MEAN      .50250 .38350 .39026 .40107 .41159 .41075 .39365 .40345 .40501 .39765 .39990 .41556 .43700 .41660 .41012 .39566
STD       .11511 .16416 .15716 .15602 .14750 .15721 .16951 .15925 .17165 .13631 .17332 .11356 .17207 .13802 .16302 .12456
```

```
                                        TABLE A3.21

                                 ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    # SET  9    A=0.50
                                     ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .47066 .47936 .47812 .52511 .49139 .50223 .51022 .49179 .52275 .51191 .52305 .50835 .48205 .50962 .46190 .51102
STD       .11545 .17167 .17349 .17992 .16903 .17939 .16227 .16115 .17664 .15890 .18735 .15843 .19137 .16423 .14383 .16750
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.59), S.S. RESIDUAL:.12691(SD:.04092))
MEAN      .47461 .47521 .47559 .52349 .48800 .49754 .52445 .49082 .51632 .50604 .51938 .49965 .47770 .50583 .45720 .50580
STD       .11601 .17454 .17520 .18009 .16002 .18131 .15986 .16020 .17741 .15907 .18795 .15892 .19226 .16360 .14682 .16170
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.7(SD: 0.45))
MEAN      .47751 .48050 .48200 .52645 .49205 .49690 .52362 .49497 .51959 .50707 .52425 .50250 .47808 .50515 .45076 .50460
STD       .11379 .17207 .17202 .17130 .15779 .17896 .15077 .15675 .17030 .15166 .18106 .15273 .18807 .15964 .14351 .16500
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.50))
MEAN      .47752 .48050 .48200 .52645 .49205 .49694 .52362 .49497 .51959 .50707 .52425 .50250 .47808 .50515 .45076 .50460
STD       .11379 .17207 .17201 .17130 .15779 .17896 .15077 .15675 .17030 .15166 .18106 .15273 .18807 .15964 .14350 .16500


                                        TABLE A3.22

                                 ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    # SET 10    A=0.50
                                     ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50567 .09873 .14550 .20043 .25759 .33206 .33305 .38493 .45579 .48029 .56460 .62690 .64517 .72215 .80869 .85623
STD       .11145 .09971 .11047 .13202 .14205 .15750 .15350 .16670 .15341 .16348 .17070 .16575 .14282 .16430 .14769 .12795
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.62), S.S. RESIDUAL:.00163(SD:.02018))
MEAN      .50437 .09745 .14446 .19733 .25718 .32972 .32991 .38546 .45875 .47943 .56167 .62260 .64317 .72152 .80827 .85906
STD       .11147 .09723 .11058 .12920 .14102 .15441 .15435 .16485 .15065 .16392 .16896 .16556 .14159 .16215 .14691 .12783
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.4(SD: 0.50))
MEAN      .50450 .09515 .14545 .19347 .25007 .32542 .33212 .38287 .45701 .48302 .56119 .61900 .64609 .72004 .80960 .85172
STD       .11149 .09414 .11013 .12575 .13787 .14989 .15248 .16284 .14649 .16319 .16944 .16300 .14025 .16088 .14592 .12804
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.51))
MEAN      .50450 .09515 .14545 .19347 .25007 .32542 .33212 .38287 .45701 .48302 .56119 .61900 .64609 .72004 .80960 .85172
STD       .11149 .09414 .11013 .12535 .13787 .14989 .15248 .16284 .14649 .16319 .16944 .16300 .14025 .16088 .14592 .12804
```

```
                                              TABLE A3.23

                                    ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 15     B SET 11     A=0.50
                                    ---                     --           --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
           ---------------------------------------------------------------------------------------------------------------------------
VALUES     0.50    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.05    0.15    0.25    0.35    0.45    0.25
           ---------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .50066 .10673 .15201 .20019 .25900 .31720 .33884 .37621 .42328 .50919 .04920 .15014 .26524 .34299 .43371 .23076
STD        .10320 .10010 .10963 .12701 .13989 .15450 .15362 .15603 .17163 .16405 .07134 .12060 .15765 .14662 .15489 .14232
           ---------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.66), S.S. RESIDUAL:.07253(SD:.02594))
MEAN       .50015 .10600 .15195 .19870 .25874 .31669 .33711 .37559 .42275 .50843 .04847 .15006 .26514 .34204 .43395 .23747
STD        .10293 .09930 .10915 .12601 .13097 .15463 .15195 .15504 .17101 .16329 .06961 .12082 .15712 .14583 .15421 .14198
           ---------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.17))
MEAN       .50050 .10574 .15109 .19711 .25796 .31696 .33778 .37662 .42193 .50825 .04855 .15792 .26260 .34549 .43725 .23691
STD        .10349 .09671 .10624 .12712 .13604 .15524 .14846 .15488 .16958 .16336 .06837 .11996 .15419 .14648 .15405 .14174
           ---------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.43))
MEAN       .50050 .10574 .15109 .19711 .25796 .31696 .33778 .37662 .42193 .50825 .04855 .15792 .26260 .34549 .43725 .23691
STD        .10349 .09671 .10624 .12712 .13604 .15524 .14846 .15488 .16958 .16336 .06837 .11996 .15419 .14648 .15405 .14174


                                              TABLE A3.24

                                    ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 15     B SET 12     A=0.50
                                    ---                     --           --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
           ---------------------------------------------------------------------------------------------------------------------------
VALUES     0.50    0.90    0.85    0.80    0.75    0.70    0.65    0.60    0.55    0.50    0.95    0.85    0.75    0.65    0.55    0.75
           ---------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .49833 .90201 .86067 .77689 .76677 .68650 .65132 .59520 .52699 .51001 .96305 .85097 .74905 .67666 .55150 .74634
STD        .11360 .09493 .12033 .11349 .12011 .15330 .10165 .15505 .15066 .16474 .06003 .11822 .15200 .15967 .16930 .13311
           ---------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.1(SD: 0.95), S.S. RESIDUAL:.07152(SD:.02397))
MEAN       .48836 .89675 .85107 .76799 .75800 .67303 .64174 .58281 .51307 .50135 .95979 .84200 .73860 .66830 .53958 .73045
STD        .11345 .09020 .12150 .13609 .13105 .15766 .18224 .15270 .15030 .16171 .06349 .12061 .15406 .15052 .16729 .13263
           ---------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.95))
MEAN       .49500 .89711 .85330 .77552 .75536 .68436 .65174 .59925 .51255 .51320 .95993 .84533 .74382 .67290 .53059 .74326
STD        .10017 .09327 .11581 .12564 .12663 .14629 .17501 .14826 .14896 .15235 .06085 .11470 .13930 .14933 .15909 .12733
           ---------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP:  96, AVE # OF ITERATIONS: 7.0(SD: 1.70))
MEAN       .50357 .89585 .84950 .77159 .75808 .67960 .65272 .59751 .51437 .51220 .95039 .84436 .74070 .67115 .53777 .74911
STD        .10949 .09364 .11431 .12451 .12946 .14221 .17404 .14738 .14751 .15041 .06136 .11400 .13544 .15088 .15036 .12653
```

```
                                             TABLE A3.25

                                   ESTIMATION OF PARAMETERS FOR
                        NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    B SET  1    K=0.70
                                            ---                   --           --     ----

PARAMETER  K       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70200 .19612 .21092 .20206 .20600 .21600 .18305 .20717 .19741 .21444 .20630 .      .      .      .
STD       .09512 .11393 .11424 .09812 .11125 .10600 .10507 .10122 .09863 .10764 .10684 .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.52), S.S. RESIDUAL:.03202(SD:.01446))
MEAN      .70150 .19394 .21002 .20209 .20670 .21621 .18250 .20672 .19660 .21440 .20590 .      .      .      .
STD       .09476 .11336 .11400 .09770 .11093 .10611 .10510 .10000 .09811 .10724 .10702 .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.20))
MEAN      .70200 .19504 .21065 .20115 .20062 .21266 .18320 .20619 .19766 .21556 .20760 .      .      .      .
STD       .09533 .11321 .11433 .09573 .10926 .10064 .10470 .10025 .09760 .10422 .10030 .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.43))
MEAN      .70200 .19504 .21065 .20115 .20062 .21266 .18320 .20619 .19766 .21556 .20760 .      .      .      .
STD       .09533 .11321 .11433 .09573 .10926 .10064 .10470 .10025 .09760 .10422 .10030 .      .      .      .
```

```
                                             TABLE A3.26

                                   ESTIMATION OF PARAMETERS FOR
                        NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    B SET  2    K=0.70
                                            ---                   --           --     ----

PARAMETER  K       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69176 .38374 .40173 .39862 .39772 .39803 .41712 .42099 .41283 .41279 .40619 .      .      .      .
STD       .11453 .13973 .14146 .13852 .12749 .14667 .13576 .13633 .13771 .14776 .13905 .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.60), S.S. RESIDUAL:.06725(SD:.02097))
MEAN      .68841 .38121 .39080 .39594 .39381 .39705 .41394 .42611 .40970 .41114 .40435 .      .      .      .
STD       .11383 .13960 .14330 .13740 .12673 .14589 .13571 .13492 .13715 .14035 .13704 .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 1.0(SD: 0.33))
MEAN      .69087 .38741 .39773 .39757 .39590 .40083 .41210 .42527 .41599 .41399 .40242 .      .      .      .
STD       .10849 .14006 .14152 .12981 .12013 .13929 .11200 .13110 .13170 .14262 .13032 .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.44))
MEAN      .69007 .38743 .39773 .39757 .39590 .40082 .41210 .42527 .41599 .41399 .40242 .      .      .      .
STD       .10849 .14006 .14152 .12981 .12013 .13920 .11200 .13110 .13170 .14262 .13032 .      .      .      .
```

```
                                        TABLE A3.27

                                 ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     E SET  3     K=0.70
                                        ---                    --            --     ----

PARAMETER  K       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
           ---------------------------------------------------------------------------------------------------------------------------
VALUES     0.70    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .69039 .51577 .51289 .50320 .49019 .48557 .53775 .49205 .52200 .47907 .49207 .       .       .       .       .
STD        .10005 .13776 .16998 .14929 .15961 .14368 .15329 .13005 .14554 .13971 .13662 .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.5(SD: 0.61), S.S. RESIDUAL:.07367(SD:.02102))
MEAN       .68976 .51228 .50503 .49591 .49056 .48263 .53226 .48671 .51660 .47583 .48938 .       .       .       .       .
STD        .10026 .13585 .17020 .14687 .15695 .14096 .15165 .13591 .14349 .14029 .13572 .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.7(SD: 0.62))
MEAN       .69266 .51052 .51261 .49035 .48183 .48557 .52985 .48975 .51654 .47957 .49224 .       .       .       .       .
STD        .10488 .12912 .16518 .14147 .15439 .13010 .14159 .13170 .13299 .13660 .12711 .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.47))
MEAN       .69265 .51052 .51260 .49035 .48183 .48556 .52985 .48974 .51654 .47957 .49223 .       .       .       .       .
STD        .10489 .12912 .16519 .14147 .15439 .13010 .14159 .13171 .13299 .13669 .12731 .       .       .       .       .
```

```
                                        TABLE A3.28

                                 ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     E SET  4     K=0.70
                                                               --            --     ----

PARAMETER  K       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
           ---------------------------------------------------------------------------------------------------------------------------
VALUES     0.70    0.10    0.15    0.20    0.25    0.30    0.40    0.50    0.70    0.80    0.85    .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .70261 .09992 .14661 .20251 .24989 .31287 .39109 .51021 .70744 .80315 .85016 .       .       .       .       .
STD        .10534 .08068 .10331 .11000 .12514 .15008 .12692 .12771 .12509 .11102 .10210 .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.9(SD: 0.57), S.S. RESIDUAL:.03865(SD:.01449))
MEAN       .70086 .10008 .14413 .20041 .24952 .31197 .39260 .51407 .70696 .80090 .85681 .       .       .       .       .
STD        .10376 .08108 .10078 .10811 .12349 .14911 .12639 .12620 .12374 .11368 .10181 .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.24))
MEAN       .70101 .09812 .14535 .20160 .24878 .31171 .39163 .51727 .70448 .80220 .85719 .       .       .       .       .
STD        .10225 .07864 .09940 .10196 .12137 .14611 .12707 .12445 .12117 .10801 .10001 .       .       .       .       .
           ---------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.61))
MEAN       .70090 .09811 .14511 .20164 .24875 .31170 .39160 .51725 .70447 .80227 .85718 .       .       .       .       .
STD        .10224 .07864 .09940 .10195 .12116 .14610 .12707 .12445 .12130 .10801 .10001 .       .       .       .       .
```

```
                                        TABLE A3.29

                                  ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    B SET  5    R=0.70
                                       ---                   --          --     ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .72109 .34020 .25567 .39300 .18751 .10032 .04156 .49710 .31250 .15232 .45900 .      .      .      .      .
STD       .10421 .13000 .12570 .13660 .10443 .08551 .05357 .13394 .13023 .09601 .13935 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.51), S.S. RESIDUAL:.03923(SD:.01350))
MEAN      .72123 .33949 .25464 .39200 .18773 .10003 .04178 .49707 .31150 .15202 .45026 .      .      .      .      .
STD       .10377 .12984 .12467 .13592 .10345 .08431 .05379 .13325 .13028 .09549 .13890 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.5(SD: 0.50))
MEAN      .72100 .34021 .25477 .39041 .18816 .10656 .04162 .49707 .30932 .15222 .45750 .      .      .      .      .
STD       .10376 .11052 .12281 .13270 .10307 .08253 .05338 .13474 .13017 .09506 .13032 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.90))
MEAN      .72100 .34021 .25477 .39041 .18816 .10655 .04162 .49706 .30932 .15221 .45750 .      .      .      .      .
STD       .10376 .11052 .12280 .13270 .10307 .08253 .05337 .13474 .13017 .09506 .13032 .      .      .      .      .
```

```
                                        TABLE A3.30

                                  ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    B SET  6    R=0.70
                                       ---                   --          --     ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .71794 .63986 .75495 .60731 .81456 .89779 .96002 .47023 .69769 .84479 .52909 .      .      .      .      .
STD       .11906 .13287 .12561 .16400 .11287 .09136 .05636 .13122 .13434 .11367 .17425 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP:  99, AVE # OF ITERATIONS 5.4(SD: 1.09), S.S. RESIDUAL:.03792(SD:.01271))
MEAN      .69591 .62030 .74501 .59690 .80715 .89080 .95590 .46010 .68476 .83530 .51651 .      .      .      .      .
STD       .12163 .13322 .12696 .15605 .10950 .09620 .05741 .12617 .13199 .10811 .17070 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 9.0(SD: 2.05))
MEAN      .71718 .64160 .75550 .61311 .81315 .89412 .95352 .48017 .69040 .83500 .51359 .      .      .      .      .
STD       .10747 .12019 .12152 .14502 .10287 .09000 .05764 .12161 .12052 .10062 .16052 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  60, AVE # OF ITERATIONS: 8.5(SD: 3.19))
MEAN      .70040 .62660 .75222 .59191 .80453 .89912 .93975 .48000 .68553 .82150 .51640 .      .      .      .      .
STD       .14401 .12713 .11900 .14073 .10114 .11657 .06134 .12504 .12332 .10167 .16629 .      .      .      .      .
```

```
                                        TABLE A3.31

                              ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    I SET  7    A=0.70
                                     ---                   --         --     ----

PARAMETER  A      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                  1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .68911 .20145 .19685 .19272 .18408 .19300 .19819 .20107 .19962 .21725 .21379 .21079 .19955 .21615 .21525 .19176
STD       .09433 .11192 .11540 .10289 .10112 .10701 .12255 .11040 .11309 .11893 .11519 .10305 .10976 .11533 .11878 .12395
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.1(SD: 0.61), S.S. RESIDUAL:.07718(SD:.02070))
MEAN      .68861 .20692 .19641 .19210 .18374 .19278 .19775 .20098 .19913 .21652 .22146 .21849 .19878 .21575 .21496 .19156
STD       .09438 .11754 .11525 .10248 .10088 .10755 .12239 .11817 .11293 .11851 .11457 .10311 .10940 .11518 .11467 .12451
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .68050 .20517 .19514 .19261 .18180 .19257 .19859 .20158 .19729 .21497 .22197 .21731 .19752 .21782 .21389 .19413
STD       .09451 .11456 .11399 .10220 .09829 .10667 .12118 .11733 .11163 .11748 .11375 .10209 .10073 .11523 .11406 .12489
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.22))
MEAN      .68050 .20517 .19514 .19261 .18180 .19257 .19859 .20158 .19729 .21497 .22197 .21731 .19752 .21782 .21389 .19413
STD       .09451 .11456 .11399 .10220 .09829 .10667 .12118 .11733 .11163 .11748 .11376 .10209 .10073 .11523 .11406 .12489


                                        TABLE A3.32

                              ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    I SET  8    A=0.70
                                     ---                   --         --     ----

PARAMETER  A      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                  1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69604 .40289 .40448 .43165 .39901 .39454 .40207 .40408 .41392 .39307 .38506 .41039 .39192 .40896 .40183 .39190
STD       .10683 .13014 .13030 .13924 .13465 .13619 .14330 .13994 .12453 .14563 .13116 .11617 .12020 .13262 .13414 .12001
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.59), S.S. RESIDUAL:.17401(SD:.04333))
MEAN      .69372 .40189 .40221 .42909 .39712 .39231 .39977 .40201 .41298 .39122 .38446 .40959 .39020 .40625 .40021 .39059
STD       .10637 .12908 .12977 .13938 .13442 .13333 .14273 .14062 .12497 .14519 .13038 .11613 .12751 .13239 .13469 .12826
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.31))
MEAN      .69600 .40074 .40259 .43171 .39676 .39552 .40111 .40541 .41570 .39100 .38481 .40709 .39124 .40682 .40251 .39346
STD       .10700 .12078 .13103 .13400 .13160 .12035 .11589 .13703 .12002 .14111 .12525 .11901 .12492 .13073 .12963 .12719
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.33))
MEAN      .69600 .40074 .40259 .43171 .39676 .39552 .40111 .40541 .41570 .39100 .38481 .40709 .39124 .40682 .40251 .39346
STD       .10700 .12078 .13103 .13400 .13160 .12035 .11589 .13703 .12002 .14111 .12525 .11901 .12492 .13073 .12963 .12719
```

```
                                   TABLE A1.33

                          ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET  9    K=0.70
                              ---                   --          --     ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------
VALUES    0.70   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ---------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70969 .49659 .49316 .50538 .50075 .51006 .50006 .51510 .49149 .48507 .51536 .49053 .51020 .49675 .50110 .49825
STD       .10050 .13492 .15706 .12575 .15505 .14463 .14394 .15692 .13479 .15155 .14373 .14302 .14391 .14295 .12967 .13448
          ---------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.64), S.S. RESIDUAL:.19290(SD:.00250))
MEAN      .70349 .49059 .48991 .50135 .49640 .51455 .50453 .51150 .48716 .48404 .51172 .48694 .50700 .49312 .49777 .49557
STD       .10010 .13566 .15571 .12496 .15457 .14409 .14497 .15767 .13437 .15318 .14322 .14260 .14330 .14466 .12961 .13464
          ---------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.39))
MEAN      .70752 .49559 .49225 .50445 .49760 .51435 .50572 .51266 .48051 .48346 .51097 .49154 .50752 .49580 .49763 .49825
STD       .10787 .12904 .14704 .11937 .14057 .14045 .13878 .15420 .12971 .14541 .13682 .13471 .13636 .14265 .12549 .13353
          ---------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.27))
MEAN      .70752 .49559 .49225 .50445 .49760 .51435 .50572 .51266 .48051 .48346 .51097 .49154 .50752 .49580 .49763 .49825
STD       .10787 .12904 .14704 .11937 .14057 .14045 .13878 .15420 .12971 .14541 .13682 .13471 .13636 .14265 .12549 .13353


                                   TABLE A1.34

                          ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET 10    K=0.70
                              ---                   --          --     ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------
VALUES    0.70   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.80   0.80   0.85
          ---------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70241 .09285 .15108 .18396 .24853 .29824 .36046 .41165 .44452 .48956 .54763 .55036 .64130 .70202 .81315 .84720
STD       .10541 .08094 .09636 .09955 .12212 .12554 .14699 .13063 .14215 .14401 .13423 .13576 .14044 .12006 .10681 .09107
          ---------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.5(SD: 0.52), S.S. RESIDUAL:.11500(SD:.03164))
MEAN      .70128 .09072 .15099 .18342 .24729 .29612 .36704 .41127 .44344 .48852 .54757 .59299 .63932 .70056 .81160 .84621
STD       .10473 .07883 .09573 .09429 .12092 .12501 .14601 .12995 .14181 .14257 .13265 .13553 .14704 .12608 .10502 .09129
          ---------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.46))
MEAN      .70350 .08863 .15463 .18627 .25003 .29608 .36430 .41346 .44515 .49035 .54860 .59514 .64267 .70193 .81122 .84829
STD       .10402 .07314 .09755 .09420 .12194 .11821 .14359 .13033 .13919 .13940 .11045 .13134 .14539 .12522 .10278 .09344
          ---------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.56))
MEAN      .70150 .08863 .15463 .18627 .25003 .29604 .36029 .41146 .44515 .49035 .54860 .59514 .64267 .70193 .81122 .84820
STD       .10402 .07314 .09755 .09820 .12194 .11821 .14359 .13033 .13919 .13940 .13045 .13134 .14539 .12522 .10278 .09344
```

TABLE A3.35

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 X SET 11 R=0.70

PARAMETER	R	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
VALUES	0.70	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.05	0.15	0.25	0.45	0.45	0.25
(SPEARMAN, # OF REP: 100)																
MEAN	.69410	.09900	.14510	.19675	.25150	.29181	.35265	.39617	.46967	.48740	.05362	.15294	.24893	.36357	.45292	.25905
STD	.09727	.07711	.09303	.09959	.10979	.11870	.11341	.14306	.14147	.14450	.06250	.10265	.10240	.11497	.13285	.11405
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.62), S.S. RESIDUAL: .10249(SD: .02765))																
MEAN	.69397	.09828	.14446	.19713	.25063	.29074	.35155	.39576	.46001	.48674	.05353	.15300	.24044	.36128	.45272	.25802
STD	.09747	.07606	.09275	.09924	.10972	.11029	.11249	.14303	.14119	.14388	.06102	.10304	.10241	.13454	.13296	.11202
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))																
MEAN	.69450	.09762	.14452	.19919	.25030	.28888	.35114	.39546	.47107	.48659	.05353	.15391	.24334	.36281	.45326	.25620
STD	.09419	.07492	.09455	.10006	.11029	.11376	.13060	.14212	.14072	.14459	.06132	.10335	.10375	.13104	.13175	.11251
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.36))																
MEAN	.69450	.09762	.14452	.19919	.25030	.28888	.35114	.39546	.47107	.48659	.05353	.15391	.24334	.36281	.45326	.25620
STD	.09419	.07492	.09455	.10006	.11029	.11376	.13060	.14212	.14072	.14459	.06132	.10335	.10375	.13104	.13175	.11251

TABLE A3.36

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 X SET 12 R=0.70

PARAMETER	R	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
VALUES	0.70	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.95	0.05	0.75	0.65	0.55	0.75
(SPEARMAN, # OF REP: 100)																
MEAN	.68465	.90509	.85604	.78808	.74940	.69000	.63901	.61063	.54367	.49170	.94384	.05967	.74567	.66921	.55959	.75913
STD	[illegible]	.07645	.10674	.12239	.11300	.12306	.15111	.14761	.14719	.14425	.07058	.10106	.13160	.13265	.15246	.11013
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.0(SD: 0.82), S.S. RESIDUAL: .09794(SD: .02271))																
MEAN	.67093	.90067	.84906	.78127	.73970	.68563	.63201	.61019	.53273	.48235	.94099	.05462	.74147	.65973	.54002	.75207
STD	.11191	.07900	.10645	.12169	.13242	.12545	.15230	.14406	.14540	.13957	.07195	.10146	.12714	.13030	.15171	.11006
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 1.06))																
MEAN	.68068	.90231	.85313	.78662	.74948	.69537	.64160	.61546	.54562	.49506	.94126	.05749	.74403	.66230	.56310	.75915
STD	.09978	.07801	.10036	.11416	.12625	.10219	.14175	.13125	.13727	.13407	.06884	.09055	.11660	.12814	.14094	.10846
(NEWTON-RAPHSON, # OF REP: 96, AVE # OF ITERATIONS: 6.9(SD: 1.59))																
MEAN	.68065	.90020	.84995	.78663	.75234	.69401	.63812	.61424	.54707	.49607	.93901	.05510	.74664	.65896	.56391	.75913
STD	.09066	.07751	.09913	.11403	.12797	.11310	.14130	.13224	.13852	.13620	.06904	.09830	.11949	.12704	.14260	.10919

```
                                        TABLE A3.37

                              ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     B SET  1     A=0.75
                                    ---                    --            --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .76015 .18367 .20141 .19506 .19344 .19100 .20363 .21313 .18113 .21042 .20032 .       .       .       .       .
STD       .09357 .09143 .10105 .09497 .10722 .09972 .09700 .11106 .09603 .10499 .10009 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.59), S.S. RESIDUAL:.03290(SD:.01095))
MEAN      .75992 .18340 .20070 .19564 .19316 .19161 .20320 .21208 .18093 .20946 .20006 .       .       .       .       .
STD       .09151 .09300 .10219 .09833 .10695 .09950 .09729 .11096 .09571 .10475 .10009 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.14))
MEAN      .76000 .18534 .19098 .19370 .19290 .19302 .20409 .21273 .18224 .20715 .20176 .       .       .       .       .
STD       .09219 .09208 .09978 .09625 .10552 .09998 .09618 .11153 .09687 .10433 .10009 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.39))
MEAN      .76000 .18534 .19098 .19370 .19290 .19302 .20409 .21273 .18224 .20715 .20176 .       .       .       .       .
STD       .09219 .09208 .09978 .09625 .10552 .09998 .09618 .11153 .09687 .10433 .10009 .       .       .       .       .


                                        TABLE A3.38

                              ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     B SET  2     A=0.75
                                    ---                    --            --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75913 .41311 .40213 .41915 .39523 .41794 .36980 .39056 .41154 .41563 .43129 .       .       .       .       .
STD       .07860 .13453 .12773 .13561 .12841 .12171 .12586 .12080 .13574 .13545 .12172 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.63), S.S. RESIDUAL:.07459(SD:.01963))
MEAN      .75555 .41010 .39863 .41714 .39305 .41533 .36033 .38768 .40071 .41444 .42040 .       .       .       .       .
STD       .07875 .13278 .12740 .13514 .12722 .12049 .12451 .12787 .13569 .13523 .12118 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.20))
MEAN      .76009 .40629 .40073 .42121 .39097 .41755 .37300 .39023 .41358 .41817 .42599 .       .       .       .       .
STD       .07946 .12623 .11944 .12020 .12691 .12100 .12175 .12579 .13432 .13420 .11912 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.14))
MEAN      .76009 .40629 .40073 .42121 .39097 .41755 .37300 .39023 .41358 .41817 .42599 .       .       .       .       .
STD       .07946 .12623 .11944 .12020 .12691 .12100 .12175 .12579 .13432 .13420 .11912 .       .       .       .       .
```

```
                                       TABLE A3.39

                              ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10     B SET  3     A=0.75
                                   ---                   --            --      ----

PARAMETER  A       B     B     B     B     B     B     B     B     B     B     B     B     B     B     B
                    1     2     3     4     5     6     7     8     9     10    11    12    13    14    15
          ---------------------------------------------------------------------------------------------
VALUES    0.75  0.50  0.50  0.50  0.50  0.50  0.50  0.50  0.50  0.50  0.50   .     .     .     .     .
          ---------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75715 .50534 .53000 .50522 .51397 .47735 .50027 .48837 .47501 .48231 .53003 .    .    .    .
STD       .09601 .14007 .13602 .12700 .15575 .13533 .12387 .11991 .12390 .13795 .12802 .    .    .    .
          ---------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.50), S.S. RESIDUAL:.00264(SD:.02190))
MEAN      .75107 .50082 .52039 .50058 .50956 .47420 .49500 .48551 .47387 .47003 .52541 .    .    .    .
STD       .09423 .14665 .13451 .12490 .15357 .13353 .12169 .11015 .12261 .13063 .12629 .    .    .    .
          ---------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.7(SD: 0.66))
MEAN      .75520 .50350 .53361 .50591 .50052 .47004 .49603 .48532 .47832 .48157 .52222 .    .    .    .
STD       .09272 .13959 .12952 .12466 .14520 .13217 .11707 .11204 .12065 .13322 .12273 .    .    .    .
          ---------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.46))
MEAN      .75520 .50350 .53361 .50591 .50052 .47004 .49603 .48532 .47832 .48157 .52222 .    .    .    .
STD       .09272 .13959 .12952 .12466 .14520 .13217 .11707 .11204 .12065 .13322 .12273 .    .    .    .


                                       TABLE A3.40

                              ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10     B SET  4     A=0.75
                                   ---                   --            --      ----

PARAMETER  A       B     B     B     B     B     B     B     B     B     B     B     B     B     B     B
                    1     2     3     4     5     6     7     8     9     10    11    12    13    14    15
          ---------------------------------------------------------------------------------------------
VALUES    0.75  0.10  0.15  0.20  0.25  0.30  0.40  0.50  0.70  0.80  0.85   .     .     .     .     .
          ---------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75482 .09963 .14991 .19467 .22419 .31069 .40503 .50021 .67939 .80708 .84676 .    .    .    .
STD       .09596 .07097 .09448 .10235 .10071 .12240 .13210 .13970 .12755 .09537 .09728 .    .    .    .
          ---------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.59), S.S. RESIDUAL:.04026(SD:.01308))
MEAN      .75467 .09852 .14814 .19318 .22617 .30002 .40641 .50757 .67918 .80618 .84601 .    .    .    .
STD       .09675 .06884 .09267 .10014 .11014 .12123 .13071 .13391 .12726 .09539 .09693 .    .    .    .
          ---------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.34))
MEAN      .75551 .09798 .15039 .19140 .22540 .30690 .41041 .51062 .67801 .80727 .84631 .    .    .    .
STD       .09532 .06750 .09276 .09766 .11256 .11711 .12904 .12914 .12636 .09351 .09730 .    .    .    .
          ---------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.61))
MEAN      .75547 .09795 .15016 .19316 .22536 .30606 .41037 .51059 .67879 .80726 .84610 .    .    .    .
STD       .09533 .06740 .09234 .09765 .11254 .11711 .12904 .12913 .12636 .09351 .09730 .    .    .    .
```

```
                                    TABLE A3.41

                            ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30     NUMBER OF ITEMS  10     B SET  5     A=0.75
                                ---                     --          --      ----

PARAMETER  A      B1     B2     B3     B4     B5     B6     B7     B8     B9     B10    B11    B12    B13    B14    B15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75159 .35102 .26555 .38342 .19094 .09586 .04629 .50863 .29550 .15154 .04651 .      .      .      .      .
STD       .09944 .12482 .09495 .12495 .11954 .07089 .04785 .12518 .11253 .10004 .12232 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.51), S.S. RESIDUAL:.06314(SD:.01444))
MEAN      .75693 .35044 .26421 .38121 .19131 .09527 .04639 .50771 .29467 .15072 .04529 .      .      .      .      .
STD       .09862 .12462 .09809 .12464 .11874 .07147 .04777 .12555 .11159 .08926 .12190 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.5(SD: 0.50))
MEAN      .75200 .35004 .26243 .38472 .19222 .09889 .04755 .50967 .29551 .15025 .04610 .      .      .      .      .
STD       .09871 .12572 .09537 .12465 .11960 .07292 .04902 .12466 .10940 .09808 .12043 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.45))
MEAN      .75200 .35004 .26243 .38471 .19222 .09889 .04755 .50966 .29550 .15025 .04609 .      .      .      .      .
STD       .09871 .12572 .09537 .12465 .11960 .07292 .04901 .12466 .10940 .09808 .12043 .      .      .      .      .


                                    TABLE A3.42

                            ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30     NUMBER OF ITEMS  10     B SET  6     A=0.75
                                ---                     --          --      ----

PARAMETER  A      B1     B2     B3     B4     B5     B6     B7     B8     B9     B10    B11    B12    B13    B14    B15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .71760 .65932 .75720 .61126 .78699 .89167 .94710 .49011 .69004 .84536 .54662 .      .      .      .      .
STD       .12061 .13184 .13451 .15109 .12067 .07919 .06422 .16013 .14232 .10963 .14698 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP:  99, AVE # OF ITERATIONS 9.4(SD: 1.75), S.S. RESIDUAL:.09033(SD:.01274))
MEAN      .69591 .64390 .74700 .59713 .77463 .88412 .94290 .47219 .68522 .83973 .53240 .      .      .      .      .
STD       .12764 .13280 .13165 .14935 .11396 .07534 .06411 .16110 .13803 .10923 .14194 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  99, AVE # OF ITERATIONS: 9.0(SD: 2.80))
MEAN      .72620 .65974 .75541 .60904 .78081 .88803 .94593 .49070 .70339 .85232 .55174 .      .      .      .      .
STD       .10939 .11942 .12197 .13693 .09950 .06802 .05719 .13928 .12220 .09211 .13532 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  69, AVE # OF ITERATIONS: 8.2(SD: 2.67))
MEAN      .70850 .67159 .75231 .58749 .77153 .88219 .91932 .47163 .68301 .84460 .53502 .      .      .      .      .
STD       .16250 .12240 .12759 .11117 .10229 .07243 .12494 .14261 .11410 .08968 .13586 .      .      .      .      .
```

TABLE A3.43

```
                                ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET  7    A=0.75
                              ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         ----------------------------------------------------------------------------------------------------------------
VALUES   0.75   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20
         ----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .74605 .19596 .22197 .18272 .19368 .19046 .19617 .19301 .20597 .21581 .21031 .20291 .20444 .21992 .18220 .18619
STD      .09590 .09993 .11800 .10344 .10109 .10643 .10358 .10526 .11118 .10883 .11591 .09769 .10856 .11236 .10258 .09931
         ----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.1(SD: 0.59), S.S. RESIDUAL:.08101(SD:.02272))
MEAN     .74570 .19555 .22163 .18250 .19366 .19050 .19545 .19292 .20551 .21512 .21037 .20280 .20412 .21993 .18257 .18599
STD      .09586 .09966 .11767 .10292 .10112 .10645 .10303 .10475 .11083 .10851 .11602 .09764 .10028 .11207 .10206 .09936
         ----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN     .74600 .19631 .22124 .18184 .19567 .19009 .19593 .19232 .20475 .21645 .21901 .20264 .20439 .21944 .18377 .18565
STD      .09500 .09882 .11561 .10082 .10021 .10666 .10318 .10373 .11094 .10835 .11704 .09679 .10690 .11106 .10242 .09872
         ----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.29))
MEAN     .74600 .19631 .22124 .18184 .19567 .19009 .19593 .19232 .20475 .21645 .21901 .20264 .20439 .21944 .18377 .18565
STD      .09500 .09882 .11561 .10082 .10021 .10666 .10318 .10373 .11094 .10835 .11704 .09679 .10690 .11106 .10242 .09872
```

TABLE A3.44

```
                                ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET  8    A=0.75
                              ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         ----------------------------------------------------------------------------------------------------------------
VALUES   0.75   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40
         ----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .75842 .42025 .40650 .40557 .40245 .39830 .39436 .41818 .41206 .40135 .42145 .39944 .39303 .38595 .38507 .37903
STD      .09404 .12200 .12132 .11701 .14842 .12844 .12162 .12413 .13007 .12946 .13133 .13223 .13123 .13420 .13422 .12504
         ----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.65), S.S. RESIDUAL:.16935(SD:.03960))
MEAN     .75644 .41002 .40477 .40411 .40078 .39720 .39361 .41647 .41071 .40080 .42065 .39830 .39130 .38410 .38433 .37806
STD      .09175 .12328 .12137 .11745 .14027 .12011 .12150 .12431 .12923 .12935 .13057 .13220 .13347 .13318 .13372 .12615
         ----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.20))
MEAN     .75700 .41563 .40359 .40359 .40421 .39350 .39546 .41708 .41001 .40413 .41895 .39925 .39210 .38003 .38554 .38209
STD      .09102 .12221 .12414 .11374 .14503 .12648 .12053 .12208 .12932 .12043 .12780 .12919 .12907 .13139 .13047 .12430
         ----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.24))
MEAN     .75700 .41563 .40359 .40359 .40421 .39350 .39546 .41708 .41001 .40413 .41895 .39925 .39210 .38003 .38554 .38209
STD      .09102 .12221 .12414 .11374 .14503 .12648 .12053 .12208 .12932 .12043 .12780 .12919 .12907 .13139 .13047 .12430
```

```
                                       TABLE A3.45

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 15     B SET  9     A=0.75
                                    ---                     --          --      ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------
VALUES     0.75   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
           ---------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .73002 .48549 .49210 .49669 .50651 .51154 .48896 .47499 .47296 .48469 .49937 .51602 .49361 .49669 .50202 .50166
STD        .09042 .15263 .14112 .13107 .13048 .11664 .12483 .12766 .14010 .12726 .14426 .15442 .13576 .13520 .13406 .13907
           ---------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.65), S.S. RESIDUAL:.20307(SD:.04600))
MEAN       .73312 .48237 .48819 .49345 .50311 .50870 .48640 .47168 .46900 .48092 .49631 .51379 .49192 .49406 .49953 .50104
STD        .09945 .15279 .14093 .13103 .13015 .13671 .12342 .12827 .13908 .12744 .14431 .15310 .13515 .13039 .13351 .13064
           ---------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.7(SD: 0.40))
MEAN       .73602 .48341 .48815 .49203 .49930 .51147 .48745 .47561 .47597 .47995 .49045 .51359 .49748 .49523 .49733 .50516
STD        .09563 .14027 .14154 .12790 .13455 .13179 .12298 .11661 .13553 .12205 .14211 .14947 .13292 .12095 .13104 .13257
           ---------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.27))
MEAN       .73602 .48341 .48815 .49203 .49930 .51147 .48745 .47561 .47597 .47995 .49045 .51359 .49748 .49523 .49733 .50516
STD        .09563 .14027 .14154 .12790 .13455 .13179 .12298 .11661 .13553 .12205 .14211 .14947 .13292 .12095 .13104 .13257
```

```
                                       TABLE A3.46

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 15     B SET 10     A=0.75
                                    ---                     --          --      ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------
VALUES     0.75   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.80   0.80   0.85
           ---------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .75272 .10197 .15100 .21609 .23177 .29049 .33760 .40460 .45210 .48955 .55042 .58160 .66501 .70919 .79097 .85105
STD        .09211 .08004 .09189 .11017 .11253 .12114 .13364 .14300 .13213 .13636 .12643 .14209 .13206 .11013 .09856 .10211
           ---------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.7(SD: 0.51), S.S. RESIDUAL:.12487(SD:.02007))
MEAN       .75129 .10105 .14992 .21572 .23251 .29460 .33015 .40352 .45146 .48813 .54850 .58082 .66400 .70882 .79750 .85216
STD        .09167 .07939 .09212 .10970 .11163 .11070 .11102 .14295 .13138 .13511 .12622 .14032 .13150 .10072 .09747 .10119
           ---------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.44))
MEAN       .75450 .10286 .15226 .21793 .23677 .29700 .34082 .40907 .45361 .49026 .55052 .57970 .66579 .71016 .79612 .85270
STD        .09106 .07940 .09063 .10969 .10767 .11972 .12894 .14432 .13374 .13295 .12270 .11913 .13180 .10815 .09638 .09969
           ---------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.48))
MEAN       .75450 .10286 .15226 .21793 .23677 .29700 .34082 .40907 .45361 .49026 .55052 .57970 .66579 .71016 .79612 .85270
STD        .09106 .07940 .09063 .10969 .10766 .11972 .12094 .14432 .13374 .13295 .12270 .11913 .13100 .10815 .09618 .09969
```

```
                                                    TABLE A3.47

                                         ESTIMATION OF PARAMETERS FOR
                          NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 15      B SET 11     A=0.75
                                              ---                    --            --     ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ------------------------------------------------------------------------------------------------------------
VALUES     0.75   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
           ------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .75170 .10855 .16201 .21694 .25017 .31501 .36429 .40191 .46750 .52530 .04901 .14906 .26276 .34776 .47652 .23919
STD        .00616 .07947 .09071 .10917 .11721 .11539 .12078 .12506 .11251 .12348 .06394 .08771 .12433 .11768 .11716 .12234
           ------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.61), S.S. RESIDUAL:.11491(SD:.03167))
MEAN       .75129 .10872 .16169 .21695 .25799 .31547 .36365 .40170 .46718 .52423 .04891 .14920 .26159 .34752 .47516 .23807
STD        .00613 .07960 .09045 .10022 .11705 .11416 .12126 .12451 .13130 .12304 .06358 .08705 .12357 .13345 .13717 .12179
           ------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN       .75100 .10891 .16099 .21367 .25973 .31836 .36264 .40213 .46757 .52624 .04747 .14659 .26017 .34909 .47482 .23787
STD        .00703 .08111 .09714 .10531 .11590 .11178 .11920 .12516 .12694 .12177 .06098 .08822 .12095 .13059 .13507 .12040
           ------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.39))
MEAN       .75100 .10891 .16099 .21367 .25973 .31836 .36264 .40213 .46757 .52624 .04747 .14659 .26017 .34909 .47482 .23787
STD        .00703 .08111 .09714 .10531 .11590 .11178 .11920 .12516 .12694 .12177 .06098 .08822 .12095 .13059 .13507 .12040


                                                    TABLE A3.48

                                         ESTIMATION OF PARAMETERS FOR
                          NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 15      B SET 12     A=0.75
                                              ---                    --            --     ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ------------------------------------------------------------------------------------------------------------
VALUES     0.75   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
           ------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .74674 .90754 .87170 .79914 .76229 .71905 .66351 .60980 .56017 .50207 .93096 .84207 .75090 .64295 .53796 .74160
STD        .10018 .07285 .10033 .11504 .12415 .13446 .12950 .13064 .13916 .15426 .06085 .10161 .11063 .13308 .14590 .12741
           ------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.9(SD: 0.68), S.S. RESIDUAL:.10715(SD:.02061))
MEAN       .72799 .90346 .86454 .79064 .75378 .71169 .63790 .60251 .55058 .48976 .93615 .83628 .74324 .63577 .52835 .73430
STD        .10151 .07103 .10295 .11533 .11915 .13465 .12797 .13062 .13739 .15265 .06217 .10142 .11484 .13201 .14507 .12648
           ------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 1.05))
MEAN       .74627 .90649 .86242 .79786 .75613 .72014 .64497 .60951 .56364 .49911 .93068 .83081 .74559 .63901 .54934 .73079
STD        .08623 .06500 .10101 .10601 .11102 .12879 .11770 .12571 .12489 .14067 .05912 .09715 .11499 .12113 .13563 .12301
           ------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP:  97, AVE # OF ITERATIONS: 6.7(SD: 1.29))
MEAN       .74912 .90306 .86006 .79640 .75441 .71869 .64733 .61267 .56521 .49920 .93701 .83750 .74201 .63939 .54930 .73971
STD        .08730 .06461 .10111 .10619 .11006 .12942 .11619 .12690 .12326 .14213 .05079 .09701 .11927 .12120 .13585 .12530
```

```
                                    TABLE A3.49

                           ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    # SET  1    A=0.00
                               ---                   --          --    ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79009 .20600 .20627 .19114 .20322 .20286 .20465 .22159 .19618 .20409 .20937 .      .      .      .      .
STD       .00558 .11925 .10195 .09511 .11657 .09907 .09200 .09181 .10132 .09500 .09745 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.4(SD: 0.56), S.S. RESIDUAL:.03657(SD:.01301))
MEAN      .79705 .20597 .20618 .19059 .20303 .20150 .20422 .22155 .19573 .20390 .20921 .      .      .      .      .
STD       .00540 .11927 .10161 .09455 .11676 .09909 .09217 .09212 .10116 .09402 .09754 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.14))
MEAN      .79850 .20630 .20730 .18907 .20339 .20150 .20550 .22310 .19550 .20706 .20917 .      .      .      .      .
STD       .00482 .11270 .10069 .09193 .11932 .09949 .09526 .09351 .09070 .09443 .09700 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.40))
MEAN      .79850 .20630 .20730 .18907 .20139 .20150 .20550 .22310 .19550 .20706 .20917 .      .      .      .      .
STD       .00482 .11270 .10069 .09193 .11932 .09949 .69526 .09351 .09070 .09443 .09700 .      .      .      .      .


                                    TABLE A3.50

                           ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 10    # SET  2    A=0.00
                               ---                   --          --    ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .81547 .40911 .38232 .41693 .42215 .39531 .38775 .39501 .40161 .39131 .40445 .      .      .      .      .
STD       .09306 .12612 .13054 .11752 .12953 .13097 .10348 .11021 .12413 .12905 .12220 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.59), S.S. RESIDUAL:.00371(SD:.02999))
MEAN      .81097 .40652 .37991 .41396 .41947 .39308 .38506 .39179 .39871 .38006 .40202 .      .      .      .      .
STD       .09130 .12569 .12960 .11546 .12033 .13037 .10299 .11667 .12303 .12097 .12211 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.30))
MEAN      .81309 .40789 .38367 .41159 .41760 .39543 .39006 .38059 .39561 .39171 .40413 .      .      .      .      .
STD       .08867 .11882 .12624 .11109 .12146 .12546 .10032 .10947 .12101 .12361 .11702 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.43))
MEAN      .81309 .40789 .38367 .41159 .41760 .39543 .39006 .38059 .39561 .39171 .40413 .      .      .      .      .
STD       .08867 .11882 .12624 .11109 .12146 .12546 .10032 .10947 .12101 .12361 .11702 .      .      .      .      .
```

```
                                   TABLE A3.51

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     B SET  3    R=0.80
                                  ---                    --           --    ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .80212 .50550 .50370 .49906 .51914 .49752 .50990 .50236 .50776 .46545 .51512 .      .      .      .      .
STD       .10112 .13907 .12864 .12986 .12503 .13060 .13609 .13555 .13367 .10570 .11200 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.59), S.S. RESIDUAL:.00779(SD:.02006))
MEAN      .79470 .50176 .49850 .49610 .51329 .49305 .50673 .49757 .50970 .46190 .51033 .      .      .      .      .
STD       .10239 .13707 .12917 .12813 .12400 .12799 .13916 .13369 .13160 .10341 .13138 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.7(SD: 0.71))
MEAN      .79626 .49799 .49216 .50077 .51207 .49372 .50870 .50023 .50609 .46518 .50016 .      .      .      .      .
STD       .09706 .13003 .12096 .12314 .12332 .12242 .13540 .12666 .12542 .10345 .12724 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.50))
MEAN      .79626 .49799 .49216 .50077 .51207 .49372 .50870 .50023 .50609 .46518 .50016 .      .      .      .      .
STD       .09706 .13003 .12096 .12314 .12332 .12202 .13540 .12666 .12542 .10345 .12724 .      .      .      .      .
```

```
                                   TABLE A3.52

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     B SET  4    R=0.80
                                  ---                    --           --    ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79768 .11783 .16509 .20359 .25305 .31457 .39234 .49354 .70705 .78053 .84697 .      .      .      .      .
STD       .08933 .08757 .11461 .12133 .11565 .13081 .12698 .13001 .11061 .10478 .08436 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.8(SD: 0.60), S.S. RESIDUAL:.04304(SD:.01521))
MEAN      .79741 .11292 .16573 .20346 .25331 .32541 .39194 .49211 .70550 .78736 .84474 .      .      .      .      .
STD       .08709 .08677 .11340 .11958 .11343 .12637 .12439 .13742 .11874 .10421 .08531 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.37))
MEAN      .79752 .11110 .16462 .20224 .25474 .31667 .39253 .48912 .70606 .79020 .84767 .      .      .      .      .
STD       .08087 .08470 .11307 .11089 .10798 .12305 .12225 .13580 .11976 .10266 .08410 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.51))
MEAN      .79749 .11117 .16459 .20220 .25470 .31661 .39250 .48909 .70605 .79019 .84766 .      .      .      .      .
STD       .08089 .08470 .11305 .11088 .10797 .12307 .12226 .13580 .11976 .10267 .08410 .      .      .      .      .
```

```
                                        TABLE A3.53

                                  ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     # SET  5     A=0.00
                                      ---                    --            --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.00    0.35    0.25    0.40    0.20    0.10    0.05    0.50    0.30    0.15    0.45     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00901 .33813 .25603 .42607 .20040 .09909 .05445 .50292 .29718 .15706 .44192 .       .       .       .       .
STD       .09244 .12761 .10994 .12062 .10309 .07189 .05620 .14037 .10654 .09097 .12755 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.50), S.S. RESIDUAL:.04410(SD:.01693))
MEAN      .00057 .33796 .25604 .42576 .19901 .09079 .05423 .50250 .29725 .15633 .44166 .       .       .       .       .
STD       .09216 .12714 .10919 .11941 .10232 .07143 .05556 .14104 .10600 .09063 .12616 ,       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.4(SD: 0.50))
MEAN      .00050 .33758 .25544 .42029 .19719 .09942 .05336 .50204 .29702 .15464 .44013 .       .       .       .       .
STD       .09149 .12576 .10032 .11704 .09037 .07193 .05372 .14310 .10472 .08922 .12616 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.46))
MEAN      .00050 .33758 .25543 .42029 .19718 .09941 .05336 .50204 .29701 .15464 .44013 .       .       .       .       .
STD       .09149 .12576 .10033 .11704 .09037 .07193 .05373 .14310 .10472 .08922 .12616 .       .       .       .       .


                                        TABLE A3.54

                                  ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  20     NUMBER OF ITEMS 10     # SET  6     A=0.00
                                      ---                    --            --      ----  .

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.00    0.65    0.75    0.60    0.80    0.90    0.95    0.50    0.70    0.85    0.55     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .02500 .66520 .77202 .60437 .79421 .90054 .94067 .49497 .71296 .86662 .52052 .       .       .       .       .
STD       .10953 .13270 .11730 .14381 .12506 .06050 .06600 .14526 .11985 .09122 .13976 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 9.2(SD: 2.03), S.S. RESIDUAL:.04635(SD:.01407))
MEAN      .00210 .65375 .76303 .59216 .78254 .90495 .93737 .48339 .70014 .85800 .51536 .       .       .       .       .
STD       .11165 .13736 .11709 .11390 .12253 .06912 .06506 .13956 .11602 .09140 .14100 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  95, AVE # OF ITERATIONS: 9.7(SD: 3.14))
MEAN      .00064 .65691 .76314 .59420 .77995 .90338 .93089 .48501 .71460 .85713 .52105 .       .       .       .       .
STD       .09251 .12455 .11367 .11064 .11030 .07111 .06144 .13440 .10775 .08860 .12837 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  60, AVE # OF ITERATIONS: 8.4(SD: 3.47))
MEAN      .01172 .66371 .75611 .60813 .78456 .83057 .90003 .48677 .69972 .84151 .51817 .       .       .       .       .
STD       .13051 .11929 .10470 .12564 .10787 .12707 .12000 .12743 .09990 .07093 .12794 .       .       .       .       .
```

TABLE A3.55

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 B SET 7 A=0.80

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.80	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	(SPEARMAN, # OF REP: 100)															
MEAN	.81018	.21457	.19120	.19494	.19015	.20539	.18660	.19609	.20738	.20232	.18860	.19669	.20168	.18469	.22164	.19953
STD	.08754	.10916	.10665	.09344	.10572	.10667	.10584	.09545	.09954	.10440	.10000	.09625	.09201	.10523	.11900	.09200
	(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.54), S.S. RESIDUAL:.09796(SD:.01023))															
MEAN	.80979	.21434	.19100	.19449	.18991	.20501	.18648	.19641	.20694	.20197	[illegible]	.19630	.20150	.18443	.22119	.19474
STD	.08743	.10909	.10645	.09140	.10942	.10639	.10570	.09500	.09930	.10390	.10074	.09612	.09197	.10516	.11971	.09275
	(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))															
MEAN	.81000	.21597	.19263	.19444	.18947	.20491	.18610	.19532	.20641	.20251	.18818	.19637	.20200	.18401	.21917	.19686
STD	.08675	.10916	.10554	.09322	.10778	.10549	.10496	.09331	.09854	.10639	.09987	.09691	.08994	.10587	.11067	.09147
	(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.26))															
MEAN	.81000	.21597	.19263	.19444	.18947	.20491	.18610	.19532	.20641	.20251	.18818	.19637	.20200	.18401	.21917	.19686
STD	.08675	.10916	.10554	.09322	.10778	.10549	.10496	.09331	.09854	.10639	.09987	.09691	.08994	.10587	.11067	.09147

TABLE A3.56

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 B SET 8 A=0.80

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.80	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
	(SPEARMAN, # OF REP: 100)															
MEAN	.79731	.39776	.38897	.39169	.41255	.41626	.41429	.41017	.38928	.40638	.41094	.39595	.39398	.39688	.39418	.40512
STD	.09101	.12431	.11844	.10877	.11615	.12874	.12200	.11925	.12594	.11934	.12887	.13713	.12369	.12627	.12818	.12674
	(MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.61), S.S. RESIDUAL:.20165(SD:.04102))															
MEAN	.79471	.39679	.38833	.39876	.41033	.41882	.41382	.40818	.38719	.40325	.40898	.39383	.39295	.39508	.39261	.40319
STD	.09113	.12426	.11848	.10822	.11562	.12824	.12234	.11875	.12477	.11898	.12819	.13697	.12397	.12579	.12696	.12669
	(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.33))															
MEAN	.79900	.39796	.37413	.39435	.41464	.41252	.41558	.40766	.39171	.40683	.40738	.39834	.39636	.39997	.39229	.40881
STD	.09128	.12164	.11659	.10334	.11640	.12631	.11998	.11328	.12445	.11734	.11634	.13449	.12029	.12421	.11962	.12437
	(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.29))															
MEAN	.79900	.39796	.37413	.39435	.41464	.41252	.41558	.40766	.39171	.40683	.40738	.39834	.39636	.39997	.39229	.40881
STD	.09128	.12164	.11659	.10334	.11640	.12631	.11998	.11328	.12445	.11734	.11634	.13449	.12029	.12421	.11962	.12437

```
                                        TABLE A3.57

                              ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET  9    A=0.00
                                      ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ----------------------------------------------------------------------------------------------------------
VALUES     0.00   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
           ----------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .01402 .50961 .50249 .48664 .50217 .52271 .49541 .48700 .51148 .50484 .48457 .48766 .52348 .49241 .49929 .47934
STD        .09654 .11108 .13027 .14119 .12754 .11252 .12309 .13355 .14008 .13213 .14169 .10914 .11509 .12309 .11569 .11207
           ----------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.62), S.S. RESIDUAL:.22422(SD:.04550))
MEAN       .00064 .50650 .50494 .48372 .49811 .52059 .49217 .48331 .50864 .50086 .48268 .48481 .52091 .49039 .49687 .47654
STD        .09670 .11168 .13025 .14004 .12711 .11138 .12132 .13278 .11907 .13219 .14096 ,10918 .11676 .12155 .11526 .11109
           ----------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.43))
MEAN       .00952 .50004 .49923 .48181 .49944 .51805 .49102 .48050 .50826 .49907 .48100 .48616 .52162 .49245 .50093 .47646
STD        .09366 .10701 .13721 .13519 .12468 .12902 .11922 .12235 .13368 .12969 .13408 .10323 .11231 .12088 .11738 .11435
           ----------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.33))
MEAN       .00952 .50004 .49923 .48181 .49944 .51805 .49102 .48050 .50826 .49907 .48100 .48616 .52162 .49245 .50093 .47646
STD        .09366 .10701 .13721 .13534 .12468 .12902 .11922 .12235 .13368 .12969 .13808 .10323 .11231 .12008 .11738 .11435
```

```
                                        TABLE A3.58

                              ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  20    NUMBER OF ITEMS 15    B SET 10    A=0.00
                                      ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ----------------------------------------------------------------------------------------------------------
VALUES     0.00   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
           ----------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .00681 .09451 .15163 .19194 .25778 .29961 .36642 .41713 .45497 .48118 .54506 .59361 .65735 .69320 .79476 .85020
STD        .09333 .07621 .08959 .09979 .11051 .11105 .12459 .11053 .13175 .14322 .12996 .15032 .13102 .11273 .09365 .08411
           ----------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.55), S.S. RESIDUAL:.13590(SD:.03250))
MEAN       .00599 .09163 .15081 .19149 .25408 .29932 .36486 .41668 .45464 .48046 .54472 .59298 .65609 .69243 .79341 .84926
STD        .09214 .07469 .08492 .10008 .10819 .11026 .12379 .10776 .13031 .14217 .12808 .14802 .12973 .11129 .09323 .08394
           ----------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.47))
MEAN       .00800 .09315 .15299 .19454 .25328 .30133 .36934 .42010 .45750 .48225 .54881 .59462 .65545 .69269 .79291 .85172
STD        .09038 .07429 .08095 .09494 .10404 .10799 .12606 .10019 .12621 .13936 .12496 .14313 .12672 .11228 .09258 .08155
           ----------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.51))
MEAN       .00800 .09315 .15299 .19454 .25328 .30132 .36934 .42009 .45750 .48224 .54883 .59462 .65545 .69269 .79291 .85172
STD        .09038 .07429 .08095 .09494 .10404 .10799 .12606 .10819 .12622 .13936 .12496 .14313 .12672 .11228 .09258 .08155
```

TABLE A3.59

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 B SET 11 A=0.80

```
PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.45   0.45   0.25
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79915 .09795 .13503 .19552 .25070 .30193 .34720 .39914 .45993 .48065 .04823 .16901 .25127 .33526 .44220 .24120
STD       .09467 .08294 .08772 .10393 .11772 .13250 .13112 .12202 .12742 .13116 .05267 .09991 .10670 .11331 .13031 .11392
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.65), S.S. RESIDUAL:.11677(SD:.02771))
MEAN      .79820 .09798 .13560 .19518 .25033 .31071 .34664 .39006 .45877 .48748 .04700 .16704 .25105 .33526 .44126 .24069
STD       .09502 .08183 .08694 .10361 .11700 .13211 .13017 .12215 .12689 .13063 .05223 .09931 .10557 .11273 .12924 .11387
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .79850 .09807 .13638 .19675 .24941 .30994 .34777 .39717 .46144 .48627 .04981 .16576 .25010 .33526 .44015 .23972
STD       .09547 .08032 .08599 .10398 .11510 .13060 .12967 .12107 .12545 .12634 .05347 .09835 .10478 .11073 .12647 .11397
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.35))
MEAN      .79850 .09807 .13638 .19675 .24941 .30994 .34777 .39717 .46144 .48627 .04981 .16576 .25010 .33526 .44015 .23972
STD       .09547 .08032 .08599 .10398 .11510 .13060 .12967 .12107 .12545 .12634 .05347 .09835 .10478 .11073 .12647 .11397
```

TABLE A3.60

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 20 NUMBER OF ITEMS 15 B SET 12 A=0.80

```
PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.55   0.55   0.75
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79925 .89635 .85682 .79211 .75555 .68612 .66256 .58635 .54529 .49792 .95159 .84585 .76089 .65271 .57202 .71699
STD       .09744 .07883 .09444 .10713 .11930 .13123 .13220 .13571 .1134[illegible] .13653 .06212 .08738 .11100 .13451 .13445 .11509
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.70), S.S. RESIDUAL:.11927(SD:.03091))
MEAN      .78525 .89808 .85241 .78855 .74948 .67921 .65476 .57730 .53893 .49116 .94918 .84381 .75492 .64556 .56360 .73249
STD       .10085 .07867 .09298 .10631 .11666 .12742 .12983 .13665 .11231 .13593 .06235 .08735 .10466 .11520 .13106 .11308
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 1.02))
MEAN      .79657 .89105 .85752 .78919 .74853 .68130 .65833 .58152 .54357 .50214 .95160 .84471 .75427 .65343 .56382 .73192
STD       .09113 .07621 .08850 .10545 .11045 .12050 .11543 .12796 .10656 .12044 .05781 .08618 .10306 .11251 .12378 .11261
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  97, AVE # OF ITERATIONS: 6.9(SD: 1.47))
MEAN      .80227 .89337 .85768 .78540 .75003 .68251 .65941 .58154 .54426 .50298 .95017 .84196 .75171 .65206 .56416 .73319
STD       .09151 .07473 .08939 .10113 .10830 .12108 .11268 .12592 ..0490 .13802 .05799 .08425 .10196 .11266 .12504 .11274
```

```
                                              TABLE A3.61

                                     ESTIMATION OF PARAMETERS FOR
                       NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     B SET  1     A=0.30
                                           ---                    --            --     ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30435 .19116 .21510 .20856 .18614 .20475 .19896 .20050 .19600 .20790 .19996 .       .       .       .       .
STD       .07632 .11505 .15121 .13040 .14250 .14980 .13282 .13745 .14018 .11950 .14315 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.60), S.S. RESIDUAL:.00081(SD:.00016))
MEAN      .30409 .19067 .21454 .20806 .18523 .20440 .19850 .19961 .19509 .20708 .19857 .       .       .       .       .
STD       .07621 .11457 .15039 .13706 .14203 .14955 .13234 .13585 .13945 .13890 .14152 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.46))
MEAN      .30433 .19017 .21439 .20808 .18911 .20709 .19750 .20011 .19830 .20663 .19853 .       .       .       .       .
STD       .07590 .11376 .15042 .13740 .14205 .14700 .13190 .13399 .14035 .13917 .13762 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.41))
MEAN      .30433 .19017 .21439 .20800 .18911 .20709 .19749 .20011 .19830 .20663 .19852 .       .       .       .       .
STD       .07590 .11376 .15042 .13740 .14205 .14700 .13190 .13399 .14035 .13917 .13762 .       .       .       .       .


                                              TABLE A3.62

                                     ESTIMATION OF PARAMETERS FOR
                       NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     B SET  2     A=0.30
                                           ---                    --            --     ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29120 .40486 .40532 .45704 .39019 .39721 .42238 .39961 .40304 .40168 .39774 .       .       .       .       .
STD       .08739 .18318 .16987 .19620 .18636 .19072 .18177 .19991 .18786 .18036 .20842 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.53), S.S. RESIDUAL:.01061(SD:.00815))
MEAN      .29082 .39998 .40485 .45188 .39440 .39150 .42781 .39566 .39605 .39679 .39503 .       .       .       .       .
STD       .08772 .18215 .16680 .19450 .18261 .18081 .18038 .19605 .18527 .17888 .20561 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.40))
MEAN      .29337 .40314 .41019 .45692 .39778 .39351 .42705 .40215 .39921 .40301 .39919 .       .       .       .       .
STD       .08736 .17091 .16741 [illegible] [illegible] .18310 .17508 .19240 .17835 .17451 .20046 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.55))
MEAN      .29337 .40316 .41020 .45690 .39777 .39349 .42706 .40219 .39920 .40378 .39919 .       .       .       .       .
STD       .08736 .17092 .16748 .18461 .17520 .18333 .17508 .19241 .17836 .17452 .20087 .       .       .       .       .
```

```
                                         TABLE A3.63

                                 ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     B SET  1     A=0.30
                                        ---                    --            --      ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29415 .49622 .49840 .49674 .50676 .50353 .52430 .51524 .48010 .47739 .50671 .      .      .      .      .
STD       .08609 .17903 .20688 .16889 .17716 .18687 .21025 .19327 .18880 .17973 .21110 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.5(SD: 0.69), S.S. RESIDUAL:.02031(SD:.00006))
MEAN      .29052 .48696 .49000 .48730 .50193 .49711 .51974 .51008 .47506 .47227 .50160 .      .      .      .      .
STD       .08653 .17939 .20612 .16034 .17070 .18174 .20569 .19124 .17690 .17036 .20796 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.68))
MEAN      .29562 .48924 .50097 .49491 .51711 .50108 .52352 .51777 .48259 .48041 .51474 .      .      .      .      .
STD       .08677 .17358 .20235 .16254 .16027 .18013 .19614 .18869 .16026 .16423 .20435 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.69))
MEAN      .29562 .48917 .50102 .49484 .51707 .50093 .52349 .51775 .48255 .48037 .51471 .      .      .      .      .
STD       .08684 .17346 .20232 .16244 .16023 .18027 .19614 .18860 .16032 .16426 .20435 .      .      .      .      .


                                         TABLE A3.64

                                 ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     B SET  4     A=0.30
                                        ---                    --            --      ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29574 .09565 .14952 .17440 .25306 .29455 .37901 .50161 .70952 .78618 .84291 .      .      .      .      .
STD       .07706 .09617 .14667 .14140 .15505 .16051 .18272 .17164 .14769 .14323 .11563 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.7(SD: 0.59), S.S. RESIDUAL:.01002(SD:.00373))
MEAN      .29495 .09650 .14923 .17116 .25162 .29225 .37000 .49521 .70760 .78494 .84152 .      .      .      .      .
STD       .07737 .09559 .14672 .13756 .15144 .15041 .18100 .16022 .14594 .14249 .11516 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.28))
MEAN      .29614 .10090 .14813 .17570 .25421 .29656 .37902 .49843 .71235 .78621 .84360 .      .      .      .      .
STD       .07798 .09733 .14195 .13410 .15423 .15731 .17675 .16365 .14159 .13991 .11491 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.6(SD: 0.69))
MEAN      .29630 .10083 .14807 .17562 .25412 .29646 .37975 .49837 .71231 .78618 .84358 .      .      .      .      .
STD       .07797 .09720 .14189 .13400 .15419 .15712 .17672 .16164 .14160 .13992 .11493 .      .      .      .      .
```

```
                                   TABLE A3.65

                           ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    S SET  5    K=0.30
                                   ---                   --          --    ----

PARAMETER  K      S      S      S      S      S      S      S      S      S      S      S      S      S      S      S
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29309 .35527 .23169 .40644 .19873 .08870 .04015 .48893 .28576 .15430 .43016 .      .      .      .      .
STD       .07293 .15075 .15101 .10056 .13210 .09601 .06549 .17420 .14975 .13001 .10893 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.60), S.S. RESIDUAL:.01031(SD:.00461))
MEAN      .29269 .35435 .23295 .40505 .19723 .08360 .04088 .48772 .28484 .15316 .42804 .      .      .      .      .
STD       .07230 .15060 .14962 .17008 .13994 .09417 .06496 .17218 .14766 .12799 .17945 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.8(SD: 0.91))
MEAN      .29400 .36020 .24002 .40799 .19924 .08533 .04106 .48910 .28940 .15533 .43182 .      .      .      .      .
STD       .07253 .14028 .15027 .17442 .12956 .09400 .06746 .16760 .14645 .12550 .17973 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.51))
MEAN      .29400 .36027 .24001 .40798 .19923 .08533 .04105 .48909 .28940 .15533 .43181 .      .      .      .      .
STD       .07253 .14027 .15027 .17442 .12955 .09400 .06746 .16760 .14645 .12557 .17973 .      .      .      .      .


                                   TABLE A3.66

                           ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    S SET  6    K=0.30
                                   ---                   --          --    ----

PARAMETER  K      S      S      S      S      S      S      S      S      S      S      S      S      S      S      S
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30071 .65121 .74906 .57802 .79258 .92378 .94779 .51803 .74017 .84587 .55728 .      .      .      .      .
STD       .08586 .10446 .17151 .21994 .14590 .10081 .08130 .20146 .19979 .12731 .10886 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP:  98, AVE # OF ITERATIONS10.0(SD: 2.68), S.S. RESIDUAL:.00991(SD:.00471))
MEAN      .28008 .63621 .73630 .55490 .78213 .91605 .94300 .48752 .72440 .83753 .52821 .      .      .      .      .
STD       .08815 .17920 .17444 .22424 .14061 .10337 .08734 .19504 .19745 .12673 .10920 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 8.0(SD: 2.72))
MEAN      .29649 .64511 .74014 .58209 .78632 .91723 .94507 .50566 .72407 .83966 .55282 .      .      .      .      .
STD       .07936 .17199 .15718 .20109 .14147 .10064 .08115 .17915 .19036 .12567 .16978 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  57, AVE # OF ITERATIONS: 8.6(SD: 2.62))
MEAN      .28265 .61299 .72735 .56260 .77291 .89808 .92235 .47317 .68334 .82200 .54960 .      .      .      .      .
STD       .11830 .17737 .15764 .20204 .14191 .10626 .09030 .15956 .21659 .12088 .16754 .      .      .      .      .
```

TABLE A3.67

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 30   NUMBER OF ITEMS 15   # SET 7   A=0.30

PARAMETER	A	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
VALUES	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
(SPEARMAN, # OF REP: 100)																
MEAN	.29949	.22990	.20964	.19633	.21310	.21092	.19610	.19214	.18869	.19675	.19608	.19659	.20654	.20496	.17499	.18101
STD	.00708	.15063	.14670	.15744	.14921	.14767	.13407	.14557	.15023	.13812	.16864	.14986	.12000	.14048	.13555	.13049
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.51), S.S. RESIDUAL:.02050(SD:.00994))																
MEAN	.29923	.22659	.20902	.19517	.21251	.21815	.19616	.19163	.18030	.19643	.19610	.19617	.20637	.20395	.17463	.18091
STD	.00698	.15730	.14627	.15708	.14870	.14604	.13447	.14517	.14981	.13754	.16012	.14963	.11973	.14819	.13581	.13049
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.14))																
MEAN	.29933	.22700	.20874	.19334	.21312	.21063	.19722	.19005	.18173	.19069	.19692	.19295	.20691	.20210	.17634	.18072
STD	.00710	.15734	.14347	.15692	.14063	.14471	.13264	.14357	.14971	.13896	.15906	.14894	.11887	.14703	.13489	.13091
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.33))																
MEAN	.29933	.22700	.20874	.19334	.21312	.21063	.19722	.19005	.18173	.19069	.19692	.19295	.20691	.20210	.17634	.18072
STD	.00710	.15734	.14347	.15692	.14063	.14471	.13264	.14357	.14971	.13896	.15906	.14894	.11887	.14703	.13489	.13091

TABLE A3.68

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 30   NUMBER OF ITEMS 15   # SET 8   A=0.30

PARAMETER	A	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
VALUES	0.30	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
(SPEARMAN, # OF REP: 100)																
MEAN	.31017	.38202	.38704	.42290	.38407	.39502	.42005	.38259	.38570	.39179	.38879	.40776	.40224	.39332	.42010	.43909
STD	.10320	.17527	.19409	.18595	.17935	.16444	.19267	.16608	.17038	.19147	.18421	.16171	.19397	.19467	.18991	.10621
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.70), S.S. RESIDUAL:.00832(SD:.01950))																
MEAN	.30912	.38210	.38525	.42028	.38200	.39162	.41839	.38060	.38170	.38050	.38021	.40679	.39954	.39347	.41700	.43693
STD	.10297	.17580	.19302	.18513	.17902	.16412	.19126	.16510	.16982	.19169	.18296	.16159	.19273	.19416	.18063	.10710
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.2(SD: 0.37))																
MEAN	.30967	.38632	.38652	.41701	.38710	.38720	.41703	.38706	.39029	.38361	.39277	.41041	.40000	.39590	.41908	.43026
STD	.10176	.17614	.18823	.18359	.17770	.16146	.18555	.16712	.17095	.18574	.18400	.15972	.19290	.19039	.18579	.10496
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.49))																
MEAN	.30967	.38632	.38652	.41701	.38710	.38720	.41703	.38706	.39029	.38361	.39277	.41041	.40000	.39590	.41908	.43026
STD	.10176	.17614	.18823	.18359	.17770	.16146	.18555	.16712	.17095	.18575	.18400	.15972	.19290	.19039	.18579	.10496

```
                                        TABLE A3.69

                                 ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    B SET  9    A=0.30
                                         ---                   --           --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29711 .50195 .51603 .49184 .50791 .49645 .49029 .49631 .48602 .50517 .52194 .49269 .50968 .45011 .50491 .51507
STD       .08874 .17355 .19519 .17475 .17667 .19368 .17124 .18404 .17790 .19554 .16738 .20203 .19251 .19810 .18356 .19223
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.61), S.S. RESIDUAL:.05115(SD:.01933))
MEAN      .29399 .49703 .51108 .48765 .50256 .49080 .48476 .49067 .48074 .49903 .51625 .48672 .50158 .44744 .50281 .51134
STD       .08955 .17660 .19458 .17481 .17414 .19258 .16977 .18341 .17047 .19565 .16539 .20301 .19297 .18869 .18513 .19252
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.45))
MEAN      .29701 .50321 .51700 .50111 .50103 .49748 .49415 .49322 .48103 .50279 .51645 .48757 .50594 .45675 .50667 .51594
STD       .08725 .16716 .18971 .16673 .16838 .18333 .15851 .18535 .17166 .18114 .15854 .19625 .18945 .17835 .17719 .18775
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.50))
MEAN      .29701 .50322 .51703 .50111 .50104 .49752 .49417 .49323 .48103 .50281 .51648 .48757 .50594 .45670 .50667 .51596
STD       .08724 .16718 .18971 .16673 .16832 .18339 .15851 .18536 .17166 .18114 .15854 .19624 .18945 .17831 .17719 .18774


                                        TABLE A3.70

                                 ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    B SET 10    A=0.30
                                         ---                   --           --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30829 .09785 .12142 .21882 .27593 .31356 .36827 .41474 .46623 .51781 .55667 .58881 .62058 .71967 .79305 .83370
STD       .07748 .09763 .10719 .11943 .15898 .15857 .15892 .17573 .17776 .18667 .17112 .15574 .17033 .15657 .14514 .11688
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.62), S.S. RESIDUAL:.03355(SD:.01257))
MEAN      .30679 .09508 .12048 .21611 .27184 .31148 .34283 .41002 .46366 .51570 .55460 .57933 .61737 .71419 .78594 .83121
STD       .07759 .09485 .10469 .11714 .14854 .15689 .15646 .17281 .17595 .18578 .17228 .15362 .17250 .15515 .14581 .11655
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.5(SD: 0.50))
MEAN      .30708 .09496 .11895 .21434 .27194 .31313 .34582 .40564 .46241 .51108 .55619 .58196 .61960 .71201 .78085 .83009
STD       .07746 .09443 .10048 .12998 .14611 .15006 .15172 .16717 .17373 .17984 .16764 .15589 .16964 .15458 .14012 .11784
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.56))
MEAN      .30708 .09496 .11894 .21429 .27194 .31311 .34582 .40564 .46241 .51108 .55619 .58196 .61959 .71201 .78085 .83088
STD       .07746 .09443 .10048 .12998 .14610 .15006 .15172 .16717 .17373 .17984 .16764 .15589 .16964 .15458 .14012 .11784
```

```
                                          TABLE A3.71

                                 ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15     B SET 11     A=0.30
                                        ---                    --           --     ----

PARAMETER  A        B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                     1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.05    0.15    0.25    0.45    0.45    0.25
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29544 .09607 .15403 .22099 .23752 .32106 .37209 .38970 .44069 .50510 .04500 .14121 .24543 .33161 .44452 .24501
STD       .04428 .10650 .11633 .15571 .11554 .15954 .17351 .17930 .17707 .18939 .07039 .12950 .15996 .18070 .16023 .15502
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.50), S.S. RESIDUAL:.02706(SD:.01079))
MEAN      .29510 .09674 .15293 .22749 .23668 .32124 .37115 .38073 .44777 .50425 .04929 .14261 .24520 .32991 .44273 .24445
STD       .00411 .10008 .11795 .15448 .13473 .15084 .17219 .17065 .17614 .18023 .07647 .12943 .15094 .18082 .16771 .15566
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.24))
MEAN      .29567 .09026 .15330 .23066 .23799 .32140 .37369 .38006 .44613 .50616 .04915 .14311 .24691 .33067 .44296 .24079
STD       .04444 .11016 .11961 .15562 .13446 .15560 .16919 .17474 .17365 .18112 .07403 .12939 .16062 .18311 .16045 .15932
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.39))
MEAN      .29567 .09026 .15330 .23066 .23799 .32140 .37369 .38006 .44613 .50616 .04915 .14311 .24691 .33067 .44296 .24079
STD       .04444 .11016 .11961 .15562 .13446 .15560 .16919 .17474 .17365 .18112 .07401 .12939 .16062 .18311 .16045 .15932


                                          TABLE A3.72

                                 ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15     B SET 12     A=0.30
                                        ---                    --           --     ----

PARAMETER  A        B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                     1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.90    0.85    0.80    0.75    0.70    0.65    0.60    0.55    0.50    0.95    0.85    0.75    0.55    0.55    0.75
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29502 .91996 .83916 .82123 .78074 .73004 .65962 .59735 .54619 .49779 .96395 .84069 .76766 .65520 .55016 [illegible]
STD       .04110 .10102 .14983 .14582 .17086 .17130 .17007 .20243 .18521 .19495 .06536 .14059 .15613 .18154 .19190 [illegible]
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.0(SD: 0.71), S.S. RESIDUAL:.02540(SD:.010[illegible]))
MEAN      .28567 .91518 .83469 .81120 .77259 .71706 .65029 .58631 .53370 .48046 .95960 .84249 .75576 .65101 [illegible] .75116
STD       .04113 .10521 .15068 .14622 .17182 .17236 .16897 .19767 .18324 .18022 .07218 .14299 .15912 .18414 .16058 .13663
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.8(SD: 1.02))
MEAN      .29057 .91720 .84310 .81943 .77423 .72690 .65902 .57919 .54220 .48811 .95605 .84148 [illegible] [illegible] .54047 .71156
STD       .07712 .09981 .14064 .13250 .15714 .16057 .15799 .18061 .17705 .17510 .07292 .13542 .16161 .17291 .16995 .17305
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  91, AVE # OF ITERATIONS: 7.2(SD: 1.61))
MEAN      .29401 .91070 .84095 .81009 .77254 .71896 .66508 .58395 .53729 .47211 .95001 .83760 .74453 .64050 .53015 .70508
STD       .04170 .10097 .13940 .13591 .15469 .15705 .16126 .19106 .17728 .16245 .06811 .13445 .15074 .17271 .16156 .17133
```

```
                                   TABLE A3.73

                            ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    R SET  1    R-0.50
                                  ---                   --          --    ----

PARAMETER  R      R      R      R      R      R      R      R      R      R      R      R      R      R      R
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.50   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49647 .20150 .18938 .20176 .21195 .21738 .21020 .20755 .21759 .19931 .19201 .      .      .      .      .
STD       .09561 .10424 .09193 .10716 .10128 .11197 .10387 .11000 .11019 .09102 .11314 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.54), S.S. RESIDUAL:.01540(SD:.00662))
MEAN      .49618 .20113 .18924 .20140 .21362 .21722 .20974 .20733 .21699 .19047 .19210 .      .      .      .      .
STD       .09566 .10378 .09737 .10649 .10086 .11357 .10332 .11061 .10979 .09135 .11256 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.17))
MEAN      .49733 .20426 .19106 .20109 .21529 .22097 .21121 .21076 .21791 .19056 .19217 .      .      .      .      .
STD       .09566 .10370 .09534 .10606 .09790 .11521 .10317 .11359 .10601 .09143 .10989 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.47))
MEAN      .49733 .20426 .19106 .20109 .21529 .22097 .21121 .21076 .21791 .19056 .19217 .      .      .      .      .
STD       .09566 .10370 .09534 .10606 .09790 .11521 .10317 .11359 .10601 .09143 .10989 .      .      .      .      .


                                   TABLE A3.74

                            ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    R SET  2    R-0.50
                                  ---                   --          --    ----

PARAMETER  R      R      R      R      R      R      R      R      R      R      R      R      R      R      R
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.50   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .40171 .37737 .41497 .39056 .39548 .41099 .39609 .37761 .40770 .42230 .42178 .      .      .      .      .
STD       .10695 .11783 .13032 .12738 .13113 .11061 .15136 .13940 .14417 .12693 .14000 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.53), S.S. RESIDUAL:.03271(SD:.01009))
MEAN      .40017 .37577 .41310 .38912 .39446 .42751 .39417 .37576 .40673 .42064 .42004 .      .      .      .      .
STD       .10628 .13792 .13964 .12635 .11268 .11064 .14410 .13900 .14426 .12606 .11979 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.13))
MEAN      .40006 .37459 .41625 .39121 .39372 .42459 .39257 .37474 .40634 .41975 .42095 .      .      .      .      .
STD       .10500 .13007 .13916 .12425 .13073 .13016 .14271 .14146 .14224 .12465 .13561 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.33))
MEAN      .40006 .37459 .41624 .39121 .39372 .42459 .39257 .37474 .40634 .41575 .42095 .      .      .      .      .
STD       .10500 .13007 .13916 .12425 .11073 .11016 .14271 .14146 .14224 .12466 .13561 .      .      .      .      .
```

```
                                   TABLE A3.75

                           ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    # SET  3    A=0.50
                                 ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50063 .48131 .48987 .49585 .50530 .50694 .49120 .49274 .50357 .49740 .52186 .      .      .      .      .
STD       .11093 .15743 .13132 .13465 .12058 .13504 .14599 .12707 .11850 .14260 .14445 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.55), S.S. RESIDUAL:.03605(SD:.01189))
MEAN      .49556 .47879 .48621 .49105 .49999 .50353 .48512 .48681 .49980 .49312 .51593 .      .      .      .      .
STD       .10980 .15769 .12932 .13171 .12091 .13283 .14769 .12696 .13081 .14107 .14270 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.57))
MEAN      .50013 .48354 .49071 .48777 .50682 .51047 .49078 .49381 .50253 .49727 .51548 .      .      .      .      .
STD       .10729 .14050 .12132 .12655 .11613 .12647 .14007 .12414 .13506 .14022 .13155 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.37))
MEAN      .50013 .48354 .49071 .48777 .50682 .51047 .49078 .49381 .50253 .49727 .51548 .      .      .      .      .
STD       .10729 .14050 .12132 .12655 .11613 .12647 .14007 .12414 .13506 .14022 .13155 .      .      .      .      .
```

```
                                   TABLE A3.76

                           ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    # SET  4    A=0.50
                                 ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49164 .09434 .15524 .20750 .25103 .29607 .40203 .50238 .71135 .82373 .85267 .      .      .      .      .
STD       .09007 .06986 .09939 .11410 .12328 .12595 .11734 .14023 .12171 .10015 .10210 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 0.66), S.S. RESIDUAL:.01710(SD:.00696))
MEAN      .49088 .09429 .15441 .20647 .25051 .29349 .40103 .50099 .70985 .82132 .85139 .      .      .      .      .
STD       .09011 .06870 .09680 .11160 .12323 .12276 .11634 .13637 .12071 .10000 .10102 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.32))
MEAN      .49201 .09615 .15104 .20790 .25303 .29550 .40611 .50203 .71208 .82172 .85100 .      .      .      .      .
STD       .08966 .06841 .09508 .11194 .12150 .11012 .13091 .13104 .12180 .09931 .10003 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.63))
MEAN      .49198 .09612 .15300 .20784 .25178 .29552 .40606 .50198 .71206 .82171 .85098 .      .      .      .      .
STD       .08969 .06836 .09506 .11190 .12146 .11011 .13090 .13103 .12180 .09912 .10003 .      .      .      .      .
```

```
                                   TABLE A3.77

                          ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    B SET  5    R=0.50
                                   ---                   --         --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------
VALUES   0.50   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49159 .34390 .24660 .39277 .20226 .11216 .06009 .50642 .27370 .15414 .45479 .      .      .      .      .
STD       .08559 .11680 .11076 .12721 .11952 .09774 .06492 .14134 .12089 .10282 .12716 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.57), S.S. RESIDUAL:.01794(SD:.00659))
MEAN      .49104 .34337 .24610 .39069 .20302 .11062 .06054 .50596 .27206 .15327 .45345 .      .      .      .      .
STD       .08573 .11564 .11793 .12706 .11010 .09604 .06522 .14102 .12056 .10130 .12608 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.5(SD: 0.50))
MEAN      .49100 .34342 .24507 .38952 .20401 .10930 .06024 .50700 .27079 .15430 .45270 .      .      .      .      .
STD       .08605 .11294 .11533 .12019 .11661 .09358 .06355 .14133 .11707 .10117 .12598 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.46))
MEAN      .49100 .34342 .24506 .38952 .20400 .10930 .06024 .50700 .27079 .15430 .45269 .      .      .      .      .
STD       .08605 .11294 .11533 .12019 .11661 .09358 .06354 .14132 .11707 .10117 .12598 .      .      .      .      .


                                   TABLE A3.78

                          ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    B SET  6    R=0.50
                                   ---                   --         --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------
VALUES   0.50   0.65   0.75   0.60   0.08   0.09   0.95   0.50   0.70   0.05   0.55    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49210 .65109 .74835 .60443 .08969 .09357 .95678 .48260 .60562 .06506 .57309 .      .      .      .      .
STD       .09764 .14590 .11937 .15409 .10647 .09365 .04408 .14189 .14119 .09557 .13299 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 9.1(SD: 1.90), S.S. RESIDUAL:.01745(SD:.00670))
MEAN      .48061 .63782 .73806 .59127 .08350 .09007 .95426 .47571 .67520 .05885 .56267 .      .      .      .      .
STD       .10137 .14749 .11462 .15192 .10285 .09150 .04856 .13971 .13017 .09307 .12600 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 8.0(SD: 1.70))
MEAN      .49322 .65151 .74276 .60129 .08721 .09627 .95743 .49770 .60501 .06023 .56507 .      .      .      .      .
STD       .09028 .11504 .11239 .13419 .09505 .08601 .04473 .12449 .12406 .08654 .12136 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  70, AVE # OF ITERATIONS: 7.7(SD: 2.57))
MEAN      .50541 .64511 .73519 .59401 .08150 .07951 .94931 .49077 .60065 .04978 .55665 .      .      .      .      .
STD       .09810 .12213 .10610 .12701 .05848 .07934 .04129 .11760 .12805 .08316 .12062 .      .      .      .      .
```

```
                                        TABLE A3.79

                              ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    B SET  7    K=0.50
                                     ---                   --          --      ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -----------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          -----------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49542 .20409 .20071 .18345 .19690 .19129 .17853 .19902 .19737 .21007 .20300 .19025 .19745 .18052 .21111 .20632
STD       .08960 .12133 .09914 .11203 .10400 .09939 .10364 .10381 .09981 .11226 .11042 .10864 .10420 .10459 .11050 .10392
          -----------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.49), S.S. RESIDUALS:.03559(SD:.01201))
MEAN      .49515 .20186 .20049 .18318 .19646 .19109 .17823 .19884 .19675 .21050 .20249 .19020 .19704 .18016 .21267 .20580
STD       .08954 .12302 .09886 .11190 .10165 .09903 .10377 .10381 .09955 .11103 .11009 .10830 .10422 .10423 .11029 .10370
          -----------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .49533 .20463 .19684 .18496 .19672 .19029 .17985 .19949 .19576 .21214 .20194 .19039 .19738 .17949 .21501 .20579
STD       .08927 .12263 .09567 .11073 .10261 .09772 .10495 .10404 .09882 .11090 .10971 .10502 .10339 .10176 .11157 .10493
          -----------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.29))
MEAN      .49533 .20463 .19684 .18496 .19672 .19029 .17985 .19949 .19576 .21214 .20194 .19039 .19738 .17949 .21501 .20579
STD       .08927 .12263 .09567 .11073 .10261 .09772 .10495 .10404 .09882 .11090 .10971 .10502 .10339 .10176 .11157 .10493


                                        TABLE A3.80

                              ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    B SET  8    K=0.50
                                     ---                   --          --      ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -----------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          -----------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50305 .40181 .40691 .41961 .42051 .39594 .41115 .39832 .40532 .41504 .42082 .40531 .42565 .40159 .38551 .3941
STD       .08083 .13251 .12729 .12695 .11102 .12714 .13397 .12546 .11955 .13112 .12801 .13977 .13343 .13376 .13152 .1346
          -----------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.64), S.S. RESIDUAL:.08531(SD:.02170))
MEAN      .50154 .39862 .40602 .41834 .42760 .39450 .40859 .39310 .40331 .41371 .41919 .40373 .42490 .40059 .38312 .3927
STD       .08869 .13255 .12781 .12704 .12999 .12719 .13318 .12560 .11923 .13112 .12793 .13991 .13290 .13433 .12909 .1341
          -----------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.31))
MEAN      .50233 .39732 .40716 .41981 .42772 .39559 .40873 .39169 .40504 .41257 .42101 .40916 .42239 .40504 .38167 .3907
STD       .08930 .11052 .12117 .12615 .11034 .12557 .12784 .12052 .11310 .13312 .12922 .13025 .12982 .13321 .12676 .1335
          -----------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.20))
MEAN      .50233 .39732 .40716 .41981 .42772 .39559 .40873 .39169 .40504 .41257 .42101 .40916 .42239 .40504 .38167 .3907
STD       .08910 .11052 .12117 .12615 .11034 .12557 .12784 .12052 .11310 .13312 .12922 .13025 .12982 .13321 .12676 .1335
```

270

```
                                         TABLE A3.01

                                 ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15    B SET  9    A=0.50
                                      ---                     --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49401 .52067 .49901 .49931 .49215 .49272 .46526 .49155 .52073 .51427 .48740 .50720 .50364 .49916 .48900 .48254
STD       .09490 .12079 .12033 .14194 .14726 .12556 .13097 .13929 .12020 .13947 .13240 .13271 .12155 .13278 .13546 .13650
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.50), S.S. RESIDUAL:.00071(SD:.02144))
MEAN      .49029 .51516 .49601 .49636 .48904 .48777 .46299 .48902 .51687 .51093 .48480 .50413 .49971 .49469 .48549 .47081
STD       .09525 .12038 .11075 .14131 .14769 .12338 .12936 .13720 .12050 .13957 .13244 .13254 .12129 .13210 .13511 .13720
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.39))
MEAN      .49435 .51592 .50096 .49046 .49099 .48464 .46062 .49266 .52097 .51200 .49240 .50504 .50216 .49342 .48396 .48415
STD       .09405 .12082 .11123 .13491 .14243 .12275 .12487 .12087 .12571 .13770 .12971 .12651 .10861 .12071 .13739 .13276
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.30))
MEAN      .49435 .51592 .50096 .49046 .49099 .48464 .46062 .49266 .52097 .51200 .49240 .50504 .50216 .49342 .48396 .48415
STD       .09405 .12082 .11123 .13491 .14243 .12275 .12487 .12087 .12571 .13770 .12971 .12651 .10861 .12071 .13739 .13276


                                         TABLE A3.02

                                 ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15    B SET 10    A=0.50
                                      ---                     --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51094 .09020 .16639 .19747 .25792 .28107 .33070 .38512 .43641 .50941 .53002 .59626 .65921 .70520 .79699 .86759
STD       .10053 .07621 .10150 .10337 .11503 .12005 .13257 .14065 .12925 .13396 .13931 .12975 .11723 .12449 .10558 .08567
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.5(SD: 0.59), S.S. RESIDUAL:.05692(SD:.01604))
MEAN      .50320 .09011 .16402 .19474 .25569 .27994 .33101 .38402 .43358 .50651 .51527 .59500 .65654 .70200 .79570 .86569
STD       .10088 .07504 .09953 .10165 .11518 .11054 .11271 .14742 .12728 .13313 .11760 .12862 .11640 .12449 .10532 .08631
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.2(SD: 0.41))
MEAN      .51000 .09037 .16205 .19619 .25982 .28108 .32905 .38507 .43543 .50558 .53707 .59723 .65410 .69969 .79779 .86351
STD       .10056 .07473 .09845 .10161 .11164 .11230 .13114 .14761 .12407 .12869 .13545 .12760 .11601 .12594 .10204 .08741
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.52))
MEAN      .51000 .09007 .16205 .19619 .25982 .28108 .32905 .38507 .43543 .50558 .53707 .59723 .65410 .69969 .79779 .86353
STD       .10056 .07473 .09845 .10161 .11164 .11230 .13114 .14761 .12407 .12869 .13545 .12760 .11601 .12594 .10204 .08741
```

```
                                   TABLE A3.03

                         ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15     B SET 11     A=0.50
                               ---                   --           --     ------

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51069 .09933 .16336 .20211 .24022 .29280 .33036 .37460 .43931 .49560 .05125 .14515 .25099 .35568 .44309 .26156
STD       .09290 .07148 .09729 .10426 .10047 .13452 .13592 .13990 .13136 .13605 .05969 .09812 .10861 .12907 .13847 .10753
          -------------------------------------------------------------------------------------------------------------
          (MINRES,' # OF REP: 100, AVE # OF ITERATIONS 6.4(SD: 0.68), S.S. RESIDUAL:.04949(SD:.01390))
MEAN      .51040 .09871 .16301 .20182 .24721 .29220 .33706 .37476 .43079 .49564 .05120 .14464 .25049 .35546 .44364 .26260
STD       .09295 .07230 .09610 .10173 .09952 .13434 .13596 .14072 .13053 .13598 .05927 .09799 .10041 .12094 .13870 .10734
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .51100 .09848 .16405 .20147 .24097 .29195 .33623 .37550 .43902 .49827 .05129 .14623 .25703 .35655 .44551 .26433
STD       .09109 .07121 .09628 .10123 .09855 .13152 .13431 .14163 .12920 .11398 .05853 .09663 .10712 .12701 .13728 .10757
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.37))
MEAN      .51100 .09848 .16405 .20147 .24097 .29195 .33623 .37550 .43902 .49827 .05129 .14623 .25703 .35655 .44551 .26431
STD       .09109 .07121 .09628 .10123 .09855 .13152 .13431 .14163 .12920 .11398 .05853 .09663 .10712 .12701 .13728 .10757
```

```
                                   TABLE A3.04

                         ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15     B SET 12     A=0.50
                               ---                   --           --     ------

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.90   0.05   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49082 .89069 .05513 .80210 .74862 .70711 .64177 .59202 .55199 .51614 .95719 .84305 .73191 .64590 .52694 .75026
STD       .09702 .07227 .10104 .10766 .11078 .12751 .14454 .13066 .10442 .15361 .05958 .10139 .12787 .11728 .13977 .11218
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.8(SD: 0.75), S.S. RESIDUAL:.04733(SD:.01444))
MEAN      .48021 .88738 .05191 .79532 .74064 .69712 .63322 .58807 .54223 .50431 .95663 .83077 .72712 .64001 .51567 .74364
STD       .09879 .07106 .10049 .10463 .11500 .12090 .14160 .12168 .14529 .15064 .05826 .10079 .12736 .11509 .13923 .13096
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.70))
MEAN      .49212 .89812 .05810 .79615 .74164 .70121 .63891 .59708 .55240 .51381 .95766 .84392 .73532 .64453 .52570 .74793
STD       .09719 .06643 .09322 .09710 .10577 .12479 .13077 .11023 .12993 .11854 .05701 .09242 .12130 .12901 .12907 .11011
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  98, AVE # OF ITERATIONS: 6.5(SD: 1.01))
MEAN      .49695 .88862 .05709 .79642 .74111 .70011 .64165 .59987 .55514 .51902 .95029 .84095 .73672 .64571 .52677 .74719
STD       .09410 .06494 .09147 .09761 .10557 .12409 .11141 .11905 .13023 .11046 .05650 .09026 .12107 .12540 .13041 .11509
```

```
                                   TABLE A3.05

                          ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10     R SET  1     R=0.70
                               ---                   --            --    ----

PARAMETER  R      R      R      R      R      R      R      R      R      R      R      R      R      R      R      R
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69241 .19939 .21060 .19576 .19127 .19925 .19694 .19833 .21302 .19827 .18522 .      .      .      .      .
STD       .04495 .10191 .09260 .09531 .09154 .09552 .08619 .09199 .09264 .08965 .09421 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.2(SD: 0.51), S.S. RESIDUAL:.02000(SD:.00603))
MEAN      .69219 .19952 .21052 .19524 .19317 .19099 .19676 .19023 .21653 .19815 .18975 .      .      .      .      .
STD       .04493 .10161 .09264 .09475 .09149 .09537 .08595 .09204 .09263 .08963 .09414 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.14))
MEAN      .69200 .19894 .21073 .19506 .19264 .19955 .19796 .19790 .21526 .19833 .18370 .      .      .      .      .
STD       .04410 .09906 .09306 .09216 .09180 .09480 .08723 .09024 .09330 .09050 .09343 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.22))
MEAN      .69200 .19894 .21073 .19506 .19264 .19955 .19796 .19790 .21526 .19833 .18370 .      .      .      .      .
STD       .04410 .09906 .09306 .09216 .09180 .09480 .08723 .09024 .09330 .09050 .09343 .      .      .      .      .


                                   TABLE A3.06

                          ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10     R SET  2     R=0.70
                               ---                   --            --    ----

PARAMETER  R      R      R      R      R      R      R      R      R      R      R      R      R      R      R      R
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69154 .41113 .38249 .41055 [illegible] .39733 .41602 .39996 .38576 .39770 .      .      .      .      .
STD       .04666 .12200 .11215 .10740 .11539 [illegible] .10224 .10753 .11071 .11939 .10330 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.55), S.S. RESIDUAL:.04772(SD:.01399))
MEAN      .69139 .40846 .38011 .41635 .37717 .40090 .39615 .41646 .39952 .38820 .39640 .      .      .      .      .
STD       .04654 .12063 .11155 .10669 .11466 .12204 .10209 .10620 .11045 .11949 .10323 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.20))
MEAN      .69441 .40304 .38520 .41961 .37484 .40220 .39798 .42327 .40251 .39066 .40253 .      .      .      .      .
STD       .04476 .11924 .10521 .10158 .11302 .11490 .10209 .10399 .10777 .11845 .10224 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.30))
MEAN      .69441 .40304 .38520 .41961 .37484 .40220 .39798 .42327 .40251 .39066 .40253 .      .      .      .      .
STD       .04476 .11924 .10521 .10158 .11302 .11490 .10209 .10399 .10777 .11848 .10224 .      .      .      .      .
```

TABLE A3.07

```
                         ESTIMATION OF PARAMETERS FOR
        NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10     K SET  3     R=0.70
                           ---                   --            --     ----

PARAMETER  R      K      K      K      K      K      K      K      K      K      K      K      K      K      K      K
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ----------------------------------------------------------------------------------------------------------
VALUES     0.70   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .69604 .50359 .52056 .49159 .49800 .49680 .49852 .51088 .51471 .48881 .50173 .      .      .      .      .
STD        .09292 .11197 .11609 .12495 .10196 .11312 .11890 .11289 .10294 .11920 .12074 .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.64), S.S. RESIDUAL:.05178(SD:.01284))
MEAN       .69048 .49910 .51613 .48894 .49562 .49316 .49532 .50847 .53019 .48442 .50035 .      .      .      .      .
STD        .09174 .11023 .11476 .12515 .10235 .11257 .11767 .11271 .10267 .11566 .12012 .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.53))
MEAN       .69401 .50081 .50804 .49441 .49890 .49655 .49593 .51238 .52760 .48796 .50410 .      .      .      .      .
STD        .09035 .10423 .11315 .12000 .10137 .10840 .11596 .11148 .10429 .10559 .11486 .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.31))
MEAN       .69401 .50081 .50804 [illegible] .49890 .49655 .49593 .51238 .52760 .48796 .50410 .      .      .      .      .
STD        .09035 .10423 [illegible] .12000 .10137 .10840 .11596 .11148 .10429 .10559 .11486 .      .      .      .      .
```

TABLE A3.08

```
                         ESTIMATION OF PARAMETERS FOR
        NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10     K SET  4     R=0.70
                           ---                   --            --     ----

PARAMETER  R      K      K      K      K      K      K      K      K      K      K      K      K      K      K      K
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ----------------------------------------------------------------------------------------------------------
VALUES     0.70   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85   .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .69723 .10061 .16057 .20119 .24529 .30623 .40454 .48920 .70432 .82004 .85517 .      .      .      .      .
STD        .08734 .06620 .08594 .08913 .08940 .11060 .10009 .10943 .10056 .09292 .07265 .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.62), S.S. RESIDUAL:.02504(SD:.00035))
MEAN       .69582 .10869 .15967 .19940 .24353 .30276 .40272 .48030 .70200 [illegible] .85407 .      .      .      .      .
STD        .08651 .06564 .08462 .08829 .08564 .10969 .10734 .10685 .10057 [illegible] .07216 .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.30));
MEAN       .69460 .10912 .16160 .19811 .24277 .30081 .40110 .48762 .70143 .81019 .85366 .      .      .      .      .
STD        .08485 .06176 .08421 .08593 .08862 .10870 .10551 .10680 .09918 .09129 .07087 .      .      .      .      .
           ----------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.42))
MEAN       .69465 .10911 .16166 .19808 .24274 .30079 .40108 .48760 .70142 .81010 .85365 .      .      .      .      .
STD        .08485 .06174 .08421 .08592 .08861 .10875 .10551 .10680 .09918 .09129 .07087 .      .      .      .      .
```

```
                                  TABLE A3.89

                          ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    I SET  5    A=0.70
                                ---                   --           --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         -----------------------------------------------------------------------------------------------------------------
VALUES   0.70   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .69638 .35093 .24750 .40514 .20796 .10016 .05134 .49546 .29169 .16102 .45066 .      .      .      .      .
STD      .07550 .10040 .08711 .10122 .08789 .06636 .04791 .11203 .11000 .07929 .10199 .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.50), S.S. RESIDUAL:.02715(SD:.00931))
MEAN     .69506 .35763 .24734 .40002 .20804 .09980 .05124 .49500 .29053 .16030 .45045 .      .      .      .      .
STD      .07546 .10782 .08672 .10117 .08729 .06546 .04777 .11207 .11039 .07022 .10072 .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.47))
MEAN     .69700 .35497 .25081 .40000 .21177 .10013 .05146 .49671 .29055 .16107 .45232 .      .      .      .      .
STD      .07626 .10600 .08706 .10112 .08626 .06492 .04740 .11250 .11643 .07742 .09757 .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.45))
MEAN     .69700 .35496 .25081 .40000 .21177 .10013 .05146 .49671 .29055 .16107 .45232 .      .      .      .      .
STD      .07626 .10600 .08706 .10112 .08626 .06492 .04740 .11250 .11643 .07741 .09757 .      .      .      .      .


                                  TABLE A3.90

                          ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    I SET  6    A=0.70
                                ---                   --           --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         -----------------------------------------------------------------------------------------------------------------
VALUES   0.70   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .71129 .64046 .72559 .59301 .80007 .89810 .94600 .48575 .67852 .85262 .55524 .      .      .      .      .
STD      .11064 .10762 .10151 .11050 .09469 .06305 .05499 .11484 .11917 .09189 .13245 .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.9(SD: 1.65), S.S. RESIDUAL:.02704(SD:.00909))
MEAN     .70203 .64398 .72003 .58752 .79719 .89309 .94312 .47913 .67092 .84872 .55219 .      .      .      .      .
STD      .10069 .10319 .09957 .11712 .09015 .06256 .05152 .11500 .11700 .08730 .12872 .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP:  99, AVE # OF ITERATIONS: 8.1(SD: 2.11))
MEAN     .70673 .64276 .72507 .58910 .80295 .89222 .94104 .48097 .67717 .84819 .55732 .      .      .      .      .
STD      .09515 .09950 .09126 .11192 .08600 .06267 .05299 .11155 .11105 .08277 .11501 .      .      .      .      .
         -----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP:  46, AVE # OF ITERATIONS: 7.6(SD: 1.09))
MEAN     .69930 .64011 .72[illegible] .58584 .80270 .88111 .92201 .48044 .67576 .84600 .56794 .      .      .      .      .
STD      .11986 .09586 .092[illegible] .10796 .08594 .11340 .11208 .10784 .11594 .07817 .12104 .      .      .      .      .
```

```
                                        TABLE A1.91

                                ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     E SET  7     A=0.70
                                      ---                    --            --     ----

PARAMETER  A       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .68002 .20374 .20465 .19203 .19313 .19823 .21267 .21503 .20464 .18910 .19553 .21400 .20411 .19969 .19345 .19920
STD       .00915 .08371 .08620 .09043 .09447 .09915 .08971 .07907 .08310 .09208 .09705 .10659 .08155 .08144 .08473 .09059
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.53), S.S. RESIDUAL:.05305(SD:.01800))
MEAN      .67965 .20433 .20420 .19251 .19308 .19806 .21202 .21400 .20429 .18890 .19510 .21472 .20401 .19916 .19330 .19897
STD       .00919 .08536 .08595 .09017 .09443 .09920 .08945 .07893 .08695 .09174 .09602 .10643 .08340 .08121 .08460 .09055
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .68000 .20130 .20100 .19452 .19307 .19866 .21134 .21460 .20267 .18940 .19594 .21197 .20572 .19939 .19506 .19735
STD       .00939 .08414 .08527 .08959 .09116 .09774 .08823 .07700 .08650 .09163 .09615 .10389 .08230 .08035 .08152 .08996
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.17))
MEAN      .68000 .20130 .20100 .19452 .19307 .19866 .21134 .21460 .20267 .18940 .19594 .21197 .20572 .19939 .19506 .19735
STD       .00939 .08414 .08527 .08959 .09116 .09774 .08823 .07700 .08650 .09163 .09615 .10389 .08230 .08035 .08152 .08996


                                        TABLE A1.92

                                ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     E SET  8     A=0.70
                                      ---                    --            --     ----

PARAMETER  A       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69336 .41620 .40119 .40979 .39990 .41519 .39255 .39974 .40338 .38413 .41007 .39847 .40034 .40192 .39746 .39308
STD       .00283 .10549 .10498 .11500 .10964 .12514 .10506 .10918 .10877 .12508 .10950 .11227 .12089 .11756 .10171 .10881
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.8(SD: 0.66), S.S. RESIDUAL:.11763(SD:.02390))
MEAN      .69123 .41593 .40213 .40081 .39732 .41330 .39115 .39830 .40127 .38245 .40994 .39787 .39853 .40041 .39649 .39279
STD       .00214 .10501 .10423 .11525 .10889 .12502 .10521 .10881 .10913 .12496 .10904 .11365 .11993 .11678 .10096 .10858
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.20))
MEAN      .69133 .41488 .40300 .40885 .39450 .40966 .39159 .39763 .40095 .38260 .40925 .39934 .39705 .39962 .39541 .39311
STD       .00173 .10359 .09820 .11014 .10636 .12038 .10685 .10424 .10387 .12256 .10585 .10891 .11642 .11187 .09904 .10644
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.30))
MEAN      .69133 .41488 .40300 .40885 .39450 .40966 .39159 .39763 .40095 .38260 .40925 .39934 .39705 .39962 .39541 .39311
STD       .00173 .10359 .09820 .11014 .10636 .12038 .10685 .10424 .10387 .12256 .10985 .10891 .11642 .11187 .09904 .10644
```

```
                                      TABLE A3.93

                                ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     # SET  9     R=0.70
                                          ---                    --            --      ----

PARAMETER  R       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69790 .49165 .49946 .49587 .49463 .51703 .49900 .49460 .48849 .50483 .49045 .51020 .49920 .50357 .52612 .50026
STD       .00331 .09370 .11367 .12741 .11955 .11695 .12067 .11223 .10851 .10555 .11610 .10433 .10332 .10422 .13020 .11420
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.57), S.S. RESIDUAL:.12084(SD:.02698))
MEAN      .69459 .49560 .49730 .49433 .49703 .51470 .49691 .49181 .48659 .50432 .48899 .51672 .49743 .50179 .52490 .49630
STD       .00267 .09346 .11290 .12620 .12015 .11617 .11978 .10945 .10807 .10519 .11671 .10373 .10336 .10427 .12976 .11635
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.34))
MEAN      .69769 .49706 .49908 .50035 .49970 .51301 .49841 .49057 .49022 .50178 .49396 .51870 .49919 .50349 .52545 .49747
STD       .00072 .09056 .11167 .12079 .11055 .11390 .11739 .10126 .10518 .10243 .11217 .09909 .10100 .10145 .13041 .11706
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.30))
MEAN      .69769 .49706 .49908 .50035 .49970 .51301 .49841 .49057 .49022 .50178 .49396 .51870 .49919 .50349 .52545 .49747
STD       .00072 .09056 .11167 .12079 .11055 .11390 .11739 .10126 .10518 .10243 .11217 .09909 .10100 .10145 .13041 .11706


                                      TABLE A3.94

                                ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     # SET 10     R=0.70
                                          ---                    --            --      ----

PARAMETER  R       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.80    0.80    0.85
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70600 .11103 .16394 .19946 .24516 .30591 .36118 .39797 .42874 .49492 .53217 .60567 .64573 .68574 .80147 .85179
STD       .00580 .07849 .08247 .08169 .09078 .11200 .11219 .11136 .10189 .12099 .11044 .12135 .10403 .10285 .09520 .07827
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.5(SD: 0.64), S.S. RESIDUAL:.08065(SD:.01693))
MEAN      .70459 .11074 .16315 .19423 .24596 .30535 .35921 .39677 .42422 .49339 .53141 .60404 .64390 .68190 .80000 .84979
STD       .00615 .06948 .08142 .07961 .04975 .11202 .11192 .11191 .09953 .12129 .10968 .12132 .10437 .10104 .09508 .07883
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.34))
MEAN      .70500 .10951 .16342 .19930 .24516 .30387 .35818 .39806 .42717 .49578 .53412 .60361 .64196 .68323 .80109 .84842
STD       .00663 .06867 .08102 .07601 .08808 .11182 .10644 .11111 .09819 .12052 .10696 .11029 .10506 .10072 .09249 .07844
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.47))
MEAN      .70500 .10951 .16342 .19930 .24516 .30387 .35818 .39806 .42717 .49578 .53412 .60361 .64196 .68323 .80109 .84842
STD       .00663 .06867 .08102 .07601 .08808 .11182 .10644 .11111 .09819 .12052 .10696 .11029 .10506 .10072 .09249 .07844
```

```
                                   TABLE A1.95

                           ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    B SET 11    E=0.70
                              ---                   --          --    ----

PARAMETER  E       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         -------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
         -------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .70733 .09600 .14666 .19750 .24619 .29390 .35135 .39000 .45266 .50397 .04782 .14204 .23790 .34477 .45179 .26149
STD      .00174 .06137 .07650 .09124 .09738 .10714 .10259 .09447 .10067 .10605 .04686 .07639 .09312 .09845 .10167 .10493
         -------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.63), S.S. RESIDUAL:.06091(SD:.01451))
MEAN     .70681 .09570 .14620 .19738 .24613 .29264 .35113 .39861 .45260 .50300 .04779 .14160 .23735 .34402 .45099 .26000
STD      .00167 .06109 .07636 .09309 .09693 .10589 .10262 .09431 .10705 .10553 .04681 .07561 .09711 .09840 .10110 .10419
         -------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN     .70700 .09504 .14503 .19724 .24640 .29143 .35279 .39861 .45238 .50399 .04830 .14197 .23986 .34359 .45070 .25975
STD      .00072 .06107 .07456 .09165 .09494 .10428 .10057 .09383 .10477 .10428 .04592 .07398 .09761 .09823 .10118 .10436
         -------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.33))
MEAN     .70700 .09504 .14503 .19724 .24640 .29143 .35279 .39061 .45238 .50399 .04830 .14197 .23986 .34359 .45070 .25975
STD      .00072 .06107 .07456 .09165 .09494 .10428 .10057 .09383 .10477 .10428 .04592 .07398 .09761 .09823 .10118 .10436


                                   TABLE A1.96

                           ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    B SET 12    E=0.70
                              ---                   --          --    ----

PARAMETER  E       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         -------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
         -------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .72003 .90757 .85667 .81116 .73009 .70335 .61830 .60769 .56104 .51547 .95899 .84915 .76256 .66042 .54733 .74710
STD      .09435 .06745 .07589 .07921 .11153 .10352 .10838 .11109 .09221 .12491 .04301 .08289 .09196 .10483 .10233 .10400
         -------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 0.60), S.S. RESIDUAL:.07100(SD:.01760))
MEAN     .70777 .90586 .85233 .80682 .73331 .69683 .63438 .59867 .55449 .49776 .95659 .84681 .75654 .65657 .54319 .74010
STD      .09423 .06655 .07460 .07850 .10958 .10381 .10003 .10766 .09353 .12457 .04332 .08201 .09086 .10516 .09895 .10419
         -------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.06))
MEAN     .71505 .90709 .85194 .80659 .73802 .69940 .61944 .60002 .55951 .50261 .95486 .84832 .75484 .66041 .54614 .74224
STD      .08800 .06315 .07190 .07516 .10298 .10376 .09301 .09712 .09207 .11552 .04277 .07848 .08695 .09706 .09407 .09840
         -------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP:  99, AVE # OF ITERATIONS: 6.4(SD: 1.30))
MEAN     .72016 .90646 .85131 .80845 .73640 .69946 .61950 .60257 .56027 .50458 .95556 .84850 .75500 .66116 .54752 .74233
STD      .10791 .06235 .07167 .07494 .10000 .10274 .09216 .09346 .09202 .11673 .04247 .07853 .08694 .09705 .09169 .09847
```

```
                                        TABLE A3.97

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     # SET  1     A=0.75
                                     ---                    --           --     ----

PARAMETER  A      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.75   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75086 .20241 .19578 .19821 .19370 .19131 .20457 .18961 .21008 .20651 .20059 .      .      .      .      .
STD       .08357 .09199 .07792 .08515 .09513 .07372 .08869 .08910 .08220 .08798 .07622 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.1(SD: 0.53), S.S. RESIDUAL:.02257(SD:.00675))
MEAN      .75049 .20217 .19511 .19802 .19325 .19105 .20440 .18919 .21778 .20691 .20034 .      .      .      .      .
STD       .08363 .09200 .07790 .08402 .09477 .07359 .08848 .08893 .08203 .08778 .07594 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75100 .20120 .19623 .19992 .19224 .19260 .20541 .18768 .21037 .20817 .20070 .      .      .      .      .
STD       .08361 .09023 .07022 .08140 .09338 .07150 .08762 .08976 .08157 .08721 .07377 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.22))
MEAN      .75100 .20120 .19623 .19992 .19224 .19260 .20541 .18768 .21037 .20817 .20070 .      .      .      .      .
STD       .08361 .09023 .07022 .08140 .09338 .07150 .08762 .08976 .08157 .08721 .07377 .      .      .      .      .
```

```
                                        TABLE A3.98

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     # SET  2     A=0.75
                                     ---                    --           --     ----

PARAMETER  A      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.75   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .76604 .40360 .41317 .40299 .39590 .38574 .39473 .37407 .40046 .39290 .39606 .      .      .      .      .
STD       .07417 .09734 .10963 .09966 .10981 .10893 .09615 .10594 .10354 .11320 .09790 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.60), S.S. RESIDUAL:.05272(SD:.01362))
MEAN      .76449 .40298 .41138 .40211 .39423 .38494 .39205 .37279 .40751 .39227 .39509 .      .      .      .      .
STD       .07374 .09584 .10919 .09880 .10921 .10781 .09571 .10569 .10116 .11297 .09702 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.20))
MEAN      .76641 .40150 .40900 .40317 .39196 .38787 .39727 .37545 .40716 .39650 .39576 .      .      .      .      .
STD       .07310 .09071 .11035 .09705 .10011 .10235 .09397 .10545 .10411 .11450 .09762 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.40))
MEAN      .76641 .40150 .40900 .40317 .39196 .38787 .39723 .37545 .40716 .39650 .39576 .      .      .      .      .
STD       .07310 .09071 .11035 .09705 .10011 .10235 .09397 .10545 .10411 .11450 .09762 .      .      .      .      .
```

```
                                        TABLE A3.99

                                ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    B SET  3    A=0.75
                                          ---                   --           --    ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50     .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74501 .50165 .51089 .51739 .50936 .48564 .52148 .48702 .49895 .51119 .49184 .         .       .       .       .
STD       .08426 .10790 .11032 .10911 .10496 .09824 .11272 .13349 .11219 .11577 .11017 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.57), S.S. RESIDUAL:.05567(SD:.01283))
MEAN      .74116 .49976 .50830 .51602 .50675 .48261 .51994 .48356 .49555 .50970 .48866 .         .       .       .       .
STD       .08140 .10665 .10863 .10097 .10408 .09834 .11209 .13270 .11121 .11585 .10881 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.50))
MEAN      .74342 .49484 .50977 .51506 .50729 .48413 .52572 .48217 .49745 .51374 .48784 .         .       .       .       .
STD       .08387 .10410 .10845 .10802 .09802 .10336 .10586 .12799 .10870 .11687 .10288 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.20))
MEAN      .74342 .49484 .50977 .51506 .50729 .48413 .52572 .48217 .49745 .51374 .48784 .         .       .       .       .
STD       .08387 .10418 .10845 .10802 .09802 .10336 .10586 .12799 .10870 .11687 .10288 .         .       .       .       .


                                        TABLE A3.100

                                ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    B SET  4    A=0.75
                                          ---                   --           --    ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.10    0.15    0.20    0.25    0.30    0.40    0.50    0.70    0.80    0.85     .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75696 .09351 .14684 .19910 .24984 .30455 .40080 .49902 .69319 .80890 .84636 .         .       .       .       .
STD       .08936 .06860 .07313 .09141 .07860 .05887 .10687 .12074 .10137 .08626 .06741 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.8(SD: 0.62), S.S. RESIDUAL:.02908(SD:.00947))
MEAN      .75697 .09324 .14660 .19717 .24852 .30651 .40843 .49894 .69263 .80816 .84619 .         .       .       .       .
STD       .08975 .06833 .07313 .08863 .07974 .09843 .10394 .12186 .10008 .08427 .06589 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.35))
MEAN      .75035 .09384 .14980 .19792 .24786 .30883 .40756 .50118 .69485 .80941 .84757 .         .       .       .       .
STD       .08881 .06553 .07105 .08550 .08002 .09535 .10146 .11928 .09950 .08253 .06349 .         .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.69))
MEAN      .75034 .09384 .14899 .19790 .24785 .30882 .40755 .50137 .69485 .80941 .84756 .         .       .       .       .
STD       .08882 .06553 .07105 .08549 .08001 .09534 .10146 .11927 .09951 .08253 .06349 .         .       .       .       .
```

```
                                                TABLE A3.101

                                        ESTIMATION OF PARAMETERS FOR
                        NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     E SET  5     A=0.75
                                            ---                    --            --     ----

PARAMETER  A        E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                     1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.35    0.25    0.40    0.20    0.10    0.05    0.50    0.30    0.15    0.45     .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75681 .33997 .26043 .41311 .18490 .09659 .05050 .51013 .31750 .15120 .44306 .       .       .       .       .
STD       .08101 .10992 .09602 .11701 .08027 .06892 .04722 .10652 .10150 .07668 .08925 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.57), S.S. RESIDUAL:.02906(SD:.01032))
MEAN      .75612 .33895 .25957 .41197 .18479 .09596 .05049 .51017 .31710 .15047 .44306 .       .       .       .       .
STD       .08229 .11016 .09605 .11604 .07963 .06702 .04713 .10549 .10101 .07675 .08921 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.48))
MEAN      .75600 .33034 .25927 .41179 .18509 .09581 .05113 .51052 .31593 .15089 .44127 .       .       .       .       .
STD       .08150 .11116 .09553 .11592 .07054 .06627 .04606 .10401 .09915 .07695 .09024 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.47))
MEAN      .75600 .33034 .25927 .41178 .18509 .09581 .05113 .51052 .31593 .15089 .44127 .       .       .       .       .
STD       .08150 .11116 .09553 .11592 .07053 .06621 .04606 .10401 .09915 .07694 .09024 .       .       .       .       .


                                                TABLE A3.102

                                        ESTIMATION OF PARAMETERS FOR
                        NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 10     E SET  6     A=0.75
                                            ---                    --            --     ----

PARAMETER  A        E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                     1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.65    0.75    0.60    0.80    0.90    0.95    0.50    0.70    0.85    0.55     .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75013 .65100 .75106 .58063 .81090 .90485 .95725 .48295 .71004 .84340 .55907 .       .       .       .       .
STD       .08693 .10090 .09555 .11750 .09151 .06765 .04275 .12402 .10148 .07702 .11960 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 9.1(SD: 1.70), S.S. RESIDUAL:.02060(SD:.00912))
MEAN      .74537 .64794 .74717 .58404 .80421 .90027 .95432 .47575 .71150 .83956 .55126 .       .       .       .       .
STD       .08740 .09493 .09244 .11329 .08764 .06701 .04451 .12156 .09031 .07457 .11031 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 8.8(SD: 2.59))
MEAN      .74934 .65198 .74600 .59204 .80230 .89971 .95583 .47712 .71082 .84132 .55184 .       .       .       .       .
STD       .07703 .08731 .08961 .10794 .08711 .06648 .04133 .11552 .08895 .07360 .11631 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  80, AVE # OF ITERATIONS: 7.3(SD: 2.95))
MEAN      .74122 .65247 .74444 .59124 .79151 .89204 .94702 .47269 .71500 .83304 .55553 .       .       .       .       .
STD       .11196 .08963 .08688 .10610 .08193 .06576 .04061 .11160 .08752 .07156 .11432 .       .       .       .       .
```

```
                                   TABLE A3.103

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    E SET  7    R=0.75
                                  ---                   --         --     ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75100 .20896 .20103 .20147 .20472 .21606 .18847 .19177 .19900 .19834 .19411 .19506 .21395 .19255 .20423 .20824
STD       .07665 .09414 .08779 .07592 .07452 .07919 .07782 .09374 .09423 .09020 .08388 .08752 .07532 .07568 .09111 .09071
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.91), S.S. RESIDUAL:.05476(SD:.01416))
MEAN      .75161 .20182 .20040 .20122 .20671 .21582 .18838 .19171 .19969 .19816 .19483 .19500 .21382 .19210 .20419 .20782
STD       .07650 .09403 .08761 .07600 .07412 .07895 .07760 .09363 .09411 .09023 .08378 .08747 .07525 .07555 .09249 .09035
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75133 .20248 .20061 .20050 .20335 .21459 .18791 .19153 .19964 .19663 .19425 .19529 .21577 .19057 .20381 .20671
STD       .07631 .09199 .08752 .07623 .07495 .07874 .07676 .09337 .09271 .08990 .08252 .08824 .07636 .07507 .09161 .08959
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.17))
MEAN      .75133 .20248 .20061 .20050 .20335 .21459 .18791 .19153 .19964 .19663 .19425 .19529 .21577 .19057 .20381 .20671
STD       .07631 .09199 .08752 .07623 .07495 .07874 .07676 .09337 .09271 .08990 .08252 .08824 .07636 .07507 .09161 .08959


                                   TABLE A3.104

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    E SET  8    R=0.75
                                  ---                   --         --     ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .73401 .37786 .37882 .41813 .37760 .39561 .39152 .38100 .40025 .40076 .39620 .40717 .40241 .41220 .40104 .41320
STD       .07799 .10449 .09536 .11380 .10179 .10525 .10178 .11204 .11231 .10000 .11890 .11934 .11449 .10959 .11288 .11676
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.65), S.S. RESIDUAL:.12468(SD:.02673))
MEAN      .73199 .37669 .37803 .41649 .37688 .39450 .39190 .38291 .39808 .39931 .39469 .40523 .40331 .41065 .39972 .41154
STD       .07823 .10436 .09548 .11179 .10138 .10502 .10195 .11137 .11120 .09995 .11061 .11872 .11435 .10804 .11241 .11640
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.10))
MEAN      .73267 .37767 .37761 .41599 .37849 .39568 .39149 .38276 .39593 .40133 .39409 .40514 .39905 .41297 .40300 .40761
STD       .07770 .10320 .09456 .11174 .09927 .10742 .09745 .10905 .10742 .09473 .11414 .11494 .11270 .16710 .10786 .11061
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.33))
MEAN      .73267 .37767 .37761 .41599 .37849 .39568 .39149 .38276 .39593 .40133 .39409 .40514 .39905 .41297 .40300 .40761
STD       .07770 .10320 .09456 .11174 .09927 .10742 .09745 .10905 .10742 .09473 .11414 .11494 .11270 .10710 .10786 .11061
```

TABLE A3.105

```
                              ESTIMATION OF PARAMETERS FOR
        NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15     B SET  9    A=0.75
                            ---                   --          --     -----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
         ----------------------------------------------------------------------------------------------------------------------------
VALUES   0.75    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
         ----------------------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .75304 .49594 .51199 .49394 .51607 .51006 .48201 .49130 .49672 .51014 .50955 .49096 .49799 .51176 .49017 .47971
STD      .07746 .12272 .10971 .11095 .10612 .10905 .11131 .11018 .10489 .10276 .10927 .10361 .10003 .09754 .10058 .10974
         ----------------------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.69), S.S. RESIDUAL:.14074(SD:.02516))
MEAN     .75012 .49454 .50925 .49219 .51378 .50663 .48045 .48903 .49509 .50022 .50772 .48979 .49539 .50996 .48703 .47690
STD      .07811 .12230 .10461 .11059 .10655 .10944 .11068 .10933 .10448 .10185 .10871 .10290 .10361 .09619 .10092 .10963
         ----------------------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.34))
MEAN     .75236 .49670 .50811 .49432 .51260 .50548 .48353 .49271 .49879 .50050 .50671 .49255 .49604 .50009 .48732 .47689
STD      .07745 .12037 .10804 .10635 .10504 .10633 .10402 .10886 .09673 .10267 .10484 .10019 .10398 .09309 .09914 .10673
         ----------------------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.25))
MEAN     .75236 .49670 .50811 .49432 .51260 .50548 .48353 .49271 .49879 .50050 .50671 .49255 .49604 .50009 .48732 .47689
STD      .07745 .12037 .10804 .10635 .10504 .10633 .10402 .10886 .09673 .10267 .10484 .10038 .10396 .09309 .09914 .10673
```

TABLE A3.106

```
                              ESTIMATION OF PARAMETERS FOR
        NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15     B SET 10    A=0.75
                            ---                   --          --     -----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
         ----------------------------------------------------------------------------------------------------------------------------
VALUES   0.75    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.80    0.80    0.85
         ----------------------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .75347 .09646 .16126 .21360 .26510 .30431 .35409 .39406 .46010 .50791 .54400 .59374 .64696 .68119 .70517 .83074
STD      .07379 .05808 .07471 .09563 .09530 .09891 .10069 .10406 .13051 .10257 .10954 .11454 .09527 .09130 .09359 .07626
         ----------------------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.63), S.S. RESIDUAL:.08852(SD:.01708))
MEAN     .75311 .09663 .16037 .21322 .26424 .30362 .35281 .39646 .46064 .50685 .54434 .59239 .64682 .68049 .70411 .83198
STD      .07281 .05922 .07582 .09525 .09349 .09826 .10142 .10233 .12962 .10157 .10064 .11316 .09427 .08994 .09350 .07606
         ----------------------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.35))
MEAN     .75367 .09761 .15911 .21200 .26331 .30570 .35222 .39833 .46725 .50609 .54519 .59261 .64904 .68142 .70412 .83915
STD      .07123 .06155 .07192 .09104 .09556 .09850 .10079 .10068 .13044 .09836 .10556 .11347 .09111 .08897 .09304 .07767
         ----------------------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.17))
MEAN     .75367 .09761 .15911 .21200 .26331 .30570 .35222 .39833 .46725 .50609 .54519 .59261 .64904 .68142 .70412 .83915
STD      .07123 .06155 .07192 .09104 .09556 .09849 .10079 .10068 .13044 .05836 .10556 .11347 .09111 .08897 .09104 .07767
```

```
                                   TABLE A3.107

                        ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     # SET 11    A=0.75
                                ---                    --           --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------------
VALUES     0.75   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
           ---------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .75094 .10591 .14194 .19016 .25497 .30242 .34207 .41112 .45717 .50013 .05593 .15426 .25099 .35003 .45569 .24001
STD        .00949 .06089 .07708 .08868 .08575 .09781 .10488 .11032 .10946 .09819 .04403 .07784 .09046 .11116 .10139 .08923
           ---------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.67), S.S. RESIDUAL:.07530(SD:.01728))
MEAN       .75016 .10596 .14161 .18969 .25308 .30149 .34209 .41018 .45645 .49940 .05574 .15392 .25044 .35757 .45488 .23992
STD        .00946 .06041 .07693 .08837 .08484 .09757 .10406 .10919 .10819 .09792 .04368 .07750 .08900 .11099 .10099 .08879
           ---------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN       .75033 .10566 .14162 .19059 .25301 .30063 .34310 .41080 .45350 .49870 .05651 .15150 .25053 .35034 .45492 .23933
STD        .00983 .05894 .07490 .08867 .08370 .09672 .10154 .10722 .10361 .09642 .04377 .07733 .08750 .11176 .10020 .08920
           ---------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.31))
MEAN       .75033 .10566 .14162 .19059 .25301 .30063 .34310 .41080 .45350 .49870 .05651 .15150 .25053 .35034 .45492 .23933
STD        .00983 .05894 .07490 .08867 .08370 .09672 .10154 .10722 .10361 .09642 .04377 .07733 .08750 .11176 .10020 .08920


                                   TABLE A3.108

                        ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     # SET 12    A=0.75
                                ---                    --           --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------------
VALUES     0.75   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
           ---------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .76979 .90203 .84763 .79862 .75010 .69360 .64661 .61257 .55640 .49573 .95047 .84779 .72977 .63839 .55816 .75613
STD        .07896 .06103 .09320 .09548 .11355 .09893 .09830 .10462 .10362 .12060 .04323 .07319 .10045 .10933 .11297 .09377
           ---------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.63), S.S. RESIDUAL:.07695(SD:.01544))
MEAN       .75852 .89970 .84442 .79480 .75304 .68930 .64232 .60456 .55050 .48808 .95241 .84495 .72614 .63433 .55319 .75210
STD        .07962 .06106 .09393 .09399 .11077 .10093 .09578 .10624 .10321 .11842 .04356 .07044 .09974 .10703 .11007 .09235
           ---------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.87))
MEAN       .76667 .89766 .84793 .79753 .75462 .69536 .64440 .60495 .55400 .49432 .95120 .84520 .72049 .64041 .55023 .75210
STD        .07421 .05888 .08964 .08937 .10166 .09919 .09373 .10330 .09885 .11577 .04374 .06653 .09235 .10506 .10007 .09014
           ---------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 6.4(SD: 1.94))
MEAN       .76926 .89787 .84417 .79823 .75533 .69673 .64549 .60600 .55575 .49594 .95125 .84560 .72938 .64156 .55160 .75107
STD        .07521 .05873 .08943 .08901 .10354 .09921 .09178 .10356 .09913 .11561 .04170 .06838 .09211 .10564 .10709 .08995
```

```
                                   TABLE A3.109

                           ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10     A SET  1     R=0.80
                                  ---                   --           --       ----

PARAMETER  R       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------
VALUES    0.80    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79302 .21014 .20091 .19544 .19940 .19931 .19704 .20208 .19395 .19876 .19611 .       .       .       .       .
STD       .07060 .07059 .08715 .08120 .08547 .09056 .07817 .08955 .08854 .08239 .07613 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.2(SD: 0.51), S.S. RESIDUAL:.02447(SD:.00770))
MEAN      .79144 .20986 .20041 .19546 .19916 .19891 .19675 .20104 .19290 .19845 .19560 .       .       .       .       .
STD       .07053 .07027 .08690 .08132 .08521 .09036 .07816 .08931 .08813 .08225 .07583 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.90))
MEAN      .79467 .20963 .20149 .19735 .19937 .19962 .19961 .20440 .19235 .20178 .19577 .       .       .       .       .
STD       .06942 .07809 .08794 .08247 .08368 .09007 .07829 .08741 .08654 .08234 .07312 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.34))
MEAN      .79467 .20963 .20149 .19735 .19937 .19962 .19961 .20440 .19235 .20178 .19577 .       .       .       .       .
STD       .06942 .07809 .08794 .08247 .08368 .09007 .07829 .08741 .08654 .08234 .07312 .       .       .       .       .


                                   TABLE A3.110

                           ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10     A SET  2     R=0.80
                                  ---                   --           --       ----

PARAMETER  R       A       A       A       A       A       A       A       A       A       A       A       A       A       A       A
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------
VALUES    0.80    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79727 .39291 .38549 .39644 .41676 .40170 .43036 .41409 .41265 .39821 .38887 .       .       .       .       .
STD       .07344 .11050 .09191 .11266 .10946 .12242 .11714 .10924 .10951 .09692 .10685 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.54), S.S. RESIDUAL:.05151(SD:.01204))
MEAN      .79407 .39119 .38314 .39443 .41498 .39975 .42909 .41242 .41088 .39713 .38596 .       .       .       .       .
STD       .07357 .11028 .09017 .11248 .10859 .12215 .11717 .10769 .10847 .09722 .10622 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.20))
MEAN      .79709 .39018 .38391 .39751 .41520 .40325 .43280 .41262 .41144 .40390 .38539 .       .       .       .       .
STD       .07154 .10506 .08580 .10611 .10462 .11423 .11340 .10014 .10487 .09428 .10342 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.33))
MEAN      .79709 .39018 .38391 .39751 .41520 .40325 .43280 .41262 .41144 .40390 .38539 .       .       .       .       .
STD       .07154 .10506 .08580 .10611 .10462 .11423 .11340 .10014 .10487 .09428 .10342 .       .       .       .       .
```

```
                                   TABLE A3.111

                           ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    # SET  1    A=0.00
                                  ---                   --          --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00507 .50757 .51139 .50016 .51329 .49589 .50020 .50197 .51254 .49563 .50926 .      .      .      .      .
STD       .06411 .09192 .10949 .11063 .11509 .10261 .10465 .10459 .09890 .10175 .10661 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.54), S.S. RESIDUAL:.06057(SD:.01505))
MEAN      .00139 .50507 .50922 .49711 .51196 .49227 .49620 .49936 .51115 .49374 .50033 .      .      .      .      .
STD       .06256 .09079 .10945 .10934 .11533 .10103 .10432 .10406 .09745 .10082 .10667 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.40))
MEAN      .00200 .50169 .51129 .49405 .51049 .49039 .49741 .49844 .51232 .49651 .51100 .      .      .      .      .
STD       .06106 .08918 .10524 .10040 .10690 .09509 .10266 .10082 .09695 .09602 .10351 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.45))
MEAN      .00200 .50169 .51129 .49405 .51049 .49039 .49741 .49844 .51232 .49651 .51100 .      .      .      .      .
STD       .06106 .08918 .10524 .10040 .10690 .09509 .10266 .10082 .09695 .09602 .10351 .      .      .      .      .


                                   TABLE A3.112

                           ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    # SET  4    A=0.00
                                  ---                   --          --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .01532 .10790 .15127 .19559 .26117 .27409 .40501 .49050 .69677 .81351 .84747 .      .      .      .      .
STD       .06027 .06509 .08038 .09027 .08905 .08965 .11466 .10457 .09230 .08139 .07692 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 0.67), S.S. RESIDUAL:.03171(SD:.00904))
MEAN      .01398 .10187 .15072 .19407 .25067 .27344 .40419 .47294 .69746 .81354 .84724 .      .      .      .      .
STD       .06064 .06140 .07895 .08459 .08732 .08427 .11372 .10468 .09097 .07900 .07650 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.42))
MEAN      .01502 .10046 .15143 .19578 .25022 .27495 .40711 .47059 .69761 .81365 .84564 .      .      .      .      .
STD       .06000 .06162 .07781 .08720 .08500 .08179 .11194 .10276 .09060 .07549 .07719 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.45))
MEAN      .01501 .10043 .15142 .19571 .25021 .27495 .40711 .47050 .69761 .81365 .84564 .      .      .      .      .
STD       .06001 .06161 .07781 .08719 .08500 .08178 .11194 .10277 .09060 .07549 .07719 .      .      .      .      .
```

```
                                   TABLE A3.113

                            ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    E SET  5    B=0.00
                                ---                   --           --     ----

PARAMETER  A      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79030 .33029 .25267 .39567 .19505 .09654 .05031 .51062 .29200 .15796 .44936 .      .      .      .      .
STD       .07249 .09906 .10710 .09413 .08298 .07052 .04473 .11255 .08894 .07411 .09480 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.61), S.S. RESIDUAL:.03137(SD:.01021))
MEAN      .78987 .33011 .25224 .39534 .19500 .09666 .05031 .50954 .29163 .15717 .44363 .      .      .      .      .
STD       .07246 .09024 .10607 .09779 .08227 .07046 .04469 .11190 .08983 .07206 .09454 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.3(SD: 0.46))
MEAN      .79167 .34045 .25315 .39972 .19689 .09739 .05129 .51112 .29206 .15872 .44481 .      .      .      .      .
STD       .07330 .09647 .10207 .09500 .08895 .06951 .04430 .10963 .08814 .07330 .09312 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 0.91))
MEAN      .79166 .34044 .25315 .39922 .19689 .09730 .05129 .51112 .29206 .15872 .44481 .      .      .      .      .
STD       .07330 .09647 .10203 .09500 .08895 .06951 .04430 .10963 .08814 .07330 .09312 .      .      .      .      .


                                   TABLE A3.114

                            ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 10    E SET  6    B=0.00
                                ---                   --           --     ----

PARAMETER  A      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .81194 .63093 .75019 .59712 .81330 .90662 .95237 .49742 .70049 .85466 .54646 .      .      .      .      .
STD       .09603 .11278 .10033 .09853 .08938 .06349 .04995 .11691 .11167 .08248 .10470 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 9.0(SD: 1.87), S.S. RESIDUAL:.02993(SD:.00973))
MEAN      .79769 .63366 .75495 .59046 .81067 .90360 .95022 .48828 .70081 .85401 .53570 .      .      .      .      .
STD       .09846 .11137 .09651 .09740 .08216 .06281 .04946 .11629 .11249 .07938 .10249 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  94, AVE # OF ITERATIONS: 9.5(SD: 2.69))
MEAN      .79962 .63051 .75161 .59100 .80640 .90489 .94899 .49200 .70430 .84426 .54000 .      .      .      .      .
STD       .07805 .10240 .09101 .09149 .08160 .06106 .04714 .10945 .10108 .07750 .09150 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  70, AVE # OF ITERATIONS: 3.6(SD: 3.19))
MEAN      .80400 .63601 .75702 .59857 .79673 .89929 .92718 .49217 .70660 .84987 .53415 .      .      .      .      .
STD       .12463 .10916 .09207 .09796 .08237 .05960 .11460 .10969 .10061 .07641 .08983 .      .      .      .      .
```

```
                                        TABLE A3.115

                                ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    X SET  7     R=0.80
                                   ---                   --          --      -----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.80    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .78744 .18989 .20002 .20230 .17936 .21316 .20594 .19460 .22199 .19919 .19642 .19757 .18597 .20997 .20740 .19785
STD       .06550 .08524 .07822 .07934 .07409 .08814 .07321 .08375 .09899 .07097 .09201 .07701 .08148 .09625 .08008 .08707
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.43), S.S. RESIDUAL:.06040(SD:.01277))
MEAN      .78730 .18981 .19991 .20200 .17906 .21314 .20579 .19432 .22187 .19920 .19621 .19726 .18590 .21018 .20725 .19751
STD       .06554 .08509 .07813 .07934 .07483 .08816 .07313 .08356 .09116 .07105 .09184 .07686 .08371 .09614 .07996 .08757
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .78800 .19156 .20173 .20133 .17782 .21473 .20673 .19473 .22321 .19950 .19615 .19725 .18810 .21144 .20619 .19865
STD       .06557 .08452 .07810 .07901 .07425 .08292 .07227 .08344 .09276 .07271 .09172 .07661 .08469 .09662 .07894 .08638
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.25))
MEAN      .78800 .19156 .20173 .20133 .17782 .21473 .20673 .19473 .22321 .19950 .19615 .19725 .18810 .21144 .20619 .19865
STD       .06557 .08452 .07810 .07901 .07425 .08292 .07227 .08344 .09276 .07271 .09172 .07661 .08469 .09662 .07894 .08638


                                        TABLE A3.116

                                ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    X SET  8     R=0.80
                                   ---                   --          --      -----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.80    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .80085 .38208 .39195 .39217 .39103 .38949 .38874 .39541 .39149 .40291 .40555 .38766 .39471 .40125 .38940 .40909
STD       .07597 .09197 .10779 .09255 .09139 .09834 .09168 .09893 .09776 .10204 .10490 .09802 .10437 .10010 .12570 .10397
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.64), S.S. RESIDUAL:.13712(SD:.02394))
MEAN      .79949 .38070 .39050 .39097 .39116 .38335 .38784 .39481 .39047 .40140 .40436 .38650 .39135 .40032 .38817 .40750
STD       .07606 .09145 .10734 .09193 .09169 .09802 .09151 .09854 .09716 .10144 .10426 .09804 .10390 .10031 .12542 .10340
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.17))
MEAN      .80033 .38180 .38947 .39114 .39103 .38362 .38932 .39043 .39072 .40173 .40540 .38815 [illegible] .39094 .38836 .40667
STD       .07513 .09060 .10577 .09175 .09521 .09505 .09036 .09748 .09341 .09859 .10493 [illegible] [illegible] .10021 .12135 .10027
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.30))
MEAN      .80033 .38180 .38947 .39114 .39103 .38162 .38932 .39043 .39072 .40173 .40540 [illegible] [illegible] .39094 .38836 .40667
STD       .07513 .09060 .10577 .09175 .09521 .09505 .09036 .09748 .09341 .09859 .10493 [illegible] [illegible] .10021 .12135 .10027
```

TABLE A3.117

```
                              ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     R SET  9     R=0.00
                              ---                    --           --       ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79658 .49456 .51090 .49678 .51100 .49660 .50296 .48550 .49092 .51008 .49617 .50760 .50596 .47705 .49910 .49006
STD       .07502 .09505 .10364 .12179 .10563 .09534 .10012 .10939 .10556 .10714 .10102 .13272 .11090 .10955 .11561 .10771
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.56), S.S. RESIDUAL:.14539(SD:.02390))
MEAN      .79241 .49213 .50923 .49552 .50876 .49420 .50047 .48406 .48033 .51572 .49448 .50500 .50351 .47569 .49699 .48958
STD       .07494 .09556 .10247 .11994 .10542 .09451 .09908 .10942 .10554 .10674 .10111 .10165 .11850 .10912 .11499 .10816
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.33))
MEAN      .79669 .49690 .51040 .49604 .50856 .49508 .49917 .48050 .49110 .51504 .49943 .50752 .50695 .47755 .49450 .49438
STD       .07484 .09346 .10220 .11492 .10260 .09353 .09483 .10519 .10266 .10332 .09500 .09596 .11672 .10423 .10094 .10455
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.35))
MEAN      .79669 .49690 .51040 .49604 .50856 .49508 .49917 .48050 .49110 .51504 .49943 .50752 .50695 .47755 .49450 .49438
STD       .07484 .09346 .10220 .11492 .10260 .09353 .09483 .10519 .10266 .10332 .09500 .09596 .11672 .10423 .10094 .10455
```

TABLE A3.118

```
                              ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  30     NUMBER OF ITEMS 15     R SET 10     R=0.00
                              ---                    --           --       ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .80674 .10137 .15454 .19506 .24519 .31071 .34253 .41165 .46922 .49805 .55576 .60001 .64593 .70241 .79700 .84590
STD       .07047 .06293 .07166 .08149 .09380 .08845 .09700 .10601 .09795 .10237 .10491 .10700 .11077 .09340 .09349 .07527
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.66), S.S. RESIDUAL:.09290(SD:.01929))
MEAN      .80562 .10016 .15341 .19411 .24526 .31703 .34104 .41177 .46393 .49764 .55455 .60733 .64963 .70149 .79694 .84521
STD       .06998 .06183 .06934 .08201 .09332 [illegible] .10659 .10587 .09770 .10169 .10317 .10475 .11101 .09391 .09225 .07494
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.30))
MEAN      .80600 .10001 .15265 .19501 .24559 .31770 .34190 .41244 .46243 .49801 .55647 .60066 .64271 .70060 .79705 .84614
STD       .06872 .06242 .06672 .08217 .09236 .08155 .10629 .10611 .09400 .10002 .10273 .10259 .10847 .09307 .09144 .07103
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.42))
MEAN      .80600 .10001 .15265 .19501 .24559 .31770 .34190 .41244 .46243 .49801 .55647 .60066 .64271 .70060 .79705 .84614
STD       .06872 .06242 .06672 .08217 .09236 .08155 .10629 .10611 .09400 .10002 .10273 .10259 .10847 .09307 .09144 .07103
```

```
                              TABLE A3.119

                     ESTIMATION OF PARAMETERS FOR
   NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    A SET 11    R=0.80
                       ---                   --          --      ----

PARAMETER  R      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79926 .09930 .14932 .19577 .23424 .30592 .34167 .40947 .43725 .50377 .04555 .15940 .26901 .33961 .45097 .25240
STD       .00051 .05605 .07764 .08731 .08570 .09451 .11269 .10011 .10492 .10809 .04091 .07275 .09023 .09736 .11280 .07358
          ----------------------------------------------------------------------------------------------------------
          (RINNES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.64), S.S. RESIDUAL:.00255(SD:.01909))
MEAN      .79077 .09497 .14913 .19580 .23303 .30534 .34050 .40936 .43653 .50344 .04556 .15898 .26870 .33957 .45049 .25182
STD       .00048 .05786 .07740 .08720 .08555 .09401 .11203 .09975 .10460 .10457 .04068 .07279 .08988 .09726 .11209 .07187
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .79900 .09803 .14925 .19675 .23404 .30395 .33950 .40983 .43719 .50246 .04703 .15794 .26896 .34120 .45017 .25251
STD       .00047 .05669 .07773 .08719 .08439 .09205 .11130 .09030 .10435 .10099 .03970 .07252 .08930 .09602 .11018 .07297
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.13))
MEAN      .79900 .09803 .14925 .19635 .23408 .30395 .33950 .40983 .43719 .50246 .04703 .15794 .26896 .34120 .45017 .25251
STD       .00047 .05669 .07773 .08719 .08439 .09205 .11130 .09030 .10435 .10099 .03970 .07252 .08930 .09602 .11018 .07297
```

```
                              TABLE A3.120

                     ESTIMATION OF PARAMETERS FOR
   NUMBER OF SUBJECTS  30    NUMBER OF ITEMS 15    A SET 12    R=0.80
                       ---                   --          --      ----

PARAMETER  R      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.80   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .81239 .91109 .85519 .81170 .73718 .72964 .65630 .60329 .54777 .50373 .94545 .84744 .75020 .64056 .54730 .75459
STD       .07974 .06018 .07360 .09113 .09708 .09983 .11759 .11365 .11261 .10201 .05033 .08570 .09483 .11456 .12143 .08946
          ----------------------------------------------------------------------------------------------------------
          (RINNES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.60), S.S. RESIDUAL:.08102(SD:.01681))
MEAN      .79575 .90701 .85203 .80550 .71191 .72220 .65209 .59500 .54113 .49210 .94286 .84507 .74313 .64125 .54230 .75229
STD       .08044 .06096 .07236 .09248 .09754 .09938 .11679 .11063 .11254 .10553 .05041 .08299 .09500 .11239 .11943 .08821
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 1.01))
MEAN      .80970 .90617 .85877 .80437 .71300 .72261 .66179 .60122 .54562 .49671 .94227 .84700 .74657 .64002 .55308 .75606
STD       .07232 .05823 .06406 .08707 .09408 .09214 .10409 .10695 .11282 .09232 .04963 .07418 .08941 .10465 .10638 .08435
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 6.2(SD: 0.94))
MEAN      .81109 .90634 .85910 .80491 .71370 .72331 .66262 .60220 .54672 .49791 .94234 .84813 .74717 .64805 .55960 .75664
STD       .07251 .05814 .06071 .08694 .09307 .09205 .10792 .10686 .11277 .09242 .04561 .07434 .08936 .10461 .10610 .08432
```

```
                                        TABLE A3.121

                                  ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    A SET  1    R=0.30
                                          ---                   --          --    ----

PARAMETER  R      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30151 .20203 .21230 .19352 .19408 .21093 .20684 .18356 .20647 .21260 .22003 .      .      .      .      .
STD       .07726 .11620 .11272 .10310 .11139 .11312 .10664 .11597 .11311 .12076 .13176 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.2(SD: 0.61), S.S. RESIDUAL:.00672(SD:.00311))
MEAN      .30124 .20267 .21190 .19257 .19360 .21037 .20646 .18334 .20562 .21105 .21961 .      .      .      .      .
STD       .07715 .11621 .11288 .10317 .11070 .11278 .10597 .11597 .11211 .12770 .13318 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.1(SD: 0.35))
MEAN      .30100 .20429 .21092 .19262 .19187 .21734 .20760 .18525 .20438 .20898 .21900 .      .      .      .      .
STD       .07645 .11946 .11103 .10498 .10745 .11161 .10397 .11465 .11109 .12621 .13208 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.39))
MEAN      .30100 .20429 .21092 .19262 .19187 .21734 .20760 .18525 .20438 .20898 .21900 .      .      .      .      .
STD       .07645 .11946 .11103 .10498 .10745 .11161 .10397 .11465 .11105 .12621 .13208 .      .      .      .      .
```

```
                                        TABLE A3.122

                                  ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    A SET  2    R=0.30
                                          ---                   --          --    ----

PARAMETER  R      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .31390 .39927 .40970 .41561 .39616 .38703 .40872 .41371 .39501 .40500 .40045 .      .      .      .      .
STD       .06815 .14066 .15056 .14410 .15227 .14812 .11797 .11600 .14904 .14525 .14359 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.57), S.S. RESIDUAL:.01542(SD:.00409))
MEAN      .31206 .39521 .40710 .41211 .39242 .38385 .40576 .41117 .39130 .40244 .40606 .      .      .      .      .
STD       .06056 .13873 .14964 .14329 .14992 .13792 .13662 .13572 .14924 .14391 .14190 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.32))
MEAN      .31403 .39703 .41403 .41581 .39645 .38620 .40190 .41138 .39206 .40799 .41092 .      .      .      .      .
STD       .06792 .13028 .14474 .13302 .14717 .13917 .13300 .13006 .14023 .13037 .13272 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.41))
MEAN      .31403 .39703 .41402 .41581 .39645 .38620 .40190 .41138 .39205 .40793 .41092 .      .      .      .      .
STD       .06792 .13028 .14474 .13302 .14717 .13917 .13300 .13006 .14022 .13037 .13272 .      .      .      .      .
```

```
                                        TABLE A3.123

                                 ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    X SET  1    R=0.30
                                      ---                   --           --    ------

PARAMETER  R      X      X      X      X      X      X      X      X      X      X      X      X      X      X      X
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29449 .49945 .50603 .51154 .48447 .52650 .50897 .51476 .50450 .51962 .47908 .      .      .      .      .
STD       .07343 .18089 .15055 .15414 .15578 .13575 .16062 .15467 .15219 .14533 .17728 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (BIRNES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.50), S.S. RESIDUAL:.03546(SD:.03535))
MEAN      .29469 .49482 .49725 .50613 .48007 .51980 .50260 .50875 .49892 .51418 .47411 .      .      .      .      .
STD       .07292 .17843 .15424 .15351 .15595 .13364 .15950 .15123 .14718 .14424 .17343 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.59))
MEAN      .29405 .49922 .49872 .51624 .48723 .52439 .50710 .51018 .50044 .52233 .47752 .      .      .      .      .
STD       .07248 .17229 .14580 .14772 .15346 .12283 .15678 .13942 .14509 .14132 .15668 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 0.47))
MEAN      .29405 .49922 .49871 .51623 .48722 .52438 .50710 .51016 .50043 .52232 .47751 .      .      .      .      .
STD       .07248 .17229 .14587 .14771 .15345 .12285 .15678 .13947 .14508 .14132 .15469 .      .      .      .      .


                                        TABLE A3.124

                                 ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    X SET  4    R=0.30
                                      ---                   --           --    ----

PARAMETER  R      X      X      X      X      X      X      X      X      X      X      X      X      X      X      X
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.60   0.80   0.85    .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29089 .07422 .16020 .20108 .25571 .31453 .40333 .49260 .60327 .82798 .87560 .      .      .      .      .
STD       .06792 .07311 .11657 .12595 .12058 .16459 .15679 .16353 .14073 .10512 .10606 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (BIRNES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.61), S.S. RESIDUAL:.00329(SD:.00312))
MEAN      .29790 .07197 .16499 .20003 .25320 .31390 .40115 .49222 .60121 .82829 .87405 .      .      .      .      .
STD       .06048 .07050 .11451 .12721 .12499 .16289 .15256 .15892 .14030 .10682 .10508 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.22))
MEAN      .29826 .07155 .16814 .20329 .25739 .30935 .39862 .49406 .60369 .82369 .87334 .      .      .      .      .
STD       .06817 .06882 .11397 .12698 .12712 .15877 .15166 .15440 .13787 .10531 .10552 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.5(SD: 0.50))
MEAN      .29823 .07151 .16808 .20321 .25733 .30930 .39858 .49402 .60366 .82368 .87331 .      .      .      .      .
STD       .06817 .06883 .11195 .12697 .12109 .15876 .15165 .15440 .13788 .10531 .10552 .      .      .      .      .
```

```
                                   TABLE A3.125

                          ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  40    NUMBER OF ITEMS  10    B SET  5    K=0.30
                              ---                    --           --    ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
        ----------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .30706 .36063 .24997 .35604 .19425 .09506 .05069 .40100 .30903 .14596 .44192 .      .      .      .      .
STD      .07070 .12539 .13590 .14112 .11206 .07775 .07207 .14596 .13306 .10903 .14493 .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.60), S.S. RESIDUAL:.00085(SD:.00920))
MEAN     .30760 .35970 .25021 .35517 .19462 .09961 .05040 .40095 .30336 .14998 .44116 .      .      .      .      .
STD      .07057 .12696 .13501 .14141 .11293 .07591 .07092 .14521 .13235 .10763 .14136 .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.5(SD: 0.50))
MEAN     .30900 .36567 .25561 .35878 .19849 .09565 .05944 .40427 .30675 .14824 .44130 .      .      .      .      .
STD      .07076 .12460 .13410 .14111 .11301 .07670 .06051 .14620 .13149 .10967 .13540 .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.50))
MEAN     .30900 .36567 .25561 .35877 .19849 .09564 .05999 .40426 .30675 .14824 .44130 .      .      .      .      .
STD      .07076 .12460 .13410 .14111 .11301 .07670 .06051 .14628 .13149 .10967 .13540 .      .      .      .      .


                                   TABLE A3.126

                          ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  40    NUMBER OF ITEMS  10    B SET  6    K=0.30
                              ---                    --           --    ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
        ----------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .29370 .60212 .75366 .59997 .80177 .90667 .94947 .40700 .72244 .85392 .56355 .      .      .      .      .
STD      .07750 .14845 .13617 .16199 .12469 .09240 .08019 .16755 .15510 .11708 .14051 .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 9.5(SD: 2.35), S.S. RESIDUAL:.00025(SD:.00373))
MEAN     .28709 .66690 .74730 .58660 .79132 .90032 .94662 .47520 .71190 .84615 .54991 .      .      .      .      .
STD      .07961 .14670 .13740 .16185 .12376 .09182 .08171 .16625 .15112 .11637 .13978 .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 7.0(SD: 1.99))
MEAN     .29032 .67411 .75756 .58905 .79151 .89945 .95034 .48525 .71535 .84409 .59785 .      .      .      .      .
STD      .07581 .11915 .12025 .14444 .11960 .08911 .06901 .15073 .14571 .11305 .14063 .      .      .      .      .
        ----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP:  71, AVE # OF ITERATIONS: 8.2(SD: 2.59))
MEAN     .27610 .67296 .76466 .50141 .78183 .88755 .94204 .47100 .70577 .87569 .53562 .      .      .      .      .
STD      .11373 .12970 .12409 .12994 .12034 .08952 .07267 .13016 .14177 .10015 .11011 .      .      .      .      .
```

```
                                        TABLE A3.127

                                 ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    X SET  7    A=0.30
                                         ---                   --         --     -----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .20996 .20835 .18248 .20768 .21040 .19690 .19749 .21077 .20770 .20836 .21966 .19504 .19999 .20250 .20799 .18526
STD       .07765 .12511 .11560 .12238 .13219 .11390 .12388 .12769 .13057 .12999 .13351 .11533 .14495 .11931 .12702 .12517
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.99), S.S. RESIDUAL:.01543(SD:.00533))
MEAN      .20970 .20785 .18167 .20674 .20932 .19573 .19707 .21038 .20738 .20009 .21403 .19477 .19096 .20202 .20701 .18493
STD       .07761 .12455 .11494 .12188 .13164 .11353 .12309 .12747 .12983 .12411 .13291 .11545 .14416 .11920 .12689 .12517
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .20975 .20740 .18280 .20594 .20814 .19416 .19642 .21135 .20585 .21009 .21172 .19413 .19874 .20293 .21017 .18598
STD       .07761 .13197 .11330 .12040 .13083 .11292 .12115 .12666 .12777 .12314 .13085 .11552 .14210 .11398 .12611 .12580
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.33))
MEAN      .20975 .20740 .18280 .20594 .20814 .19416 .19662 .21135 .20585 .21009 .21172 .19413 .19874 .20293 .21017 .18598
STD       .07761 .13197 .11330 .12040 .13083 .11292 .12115 .12666 .12777 .12314 .13085 .11552 .14210 .11398 .12611 .12580


                                        TABLE A3.128

                                 ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    X SET  8    A=0.[illegible]
                                         ---                   --         --     -----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.30    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30013 .44498 .40153 .42528 .39936 .38945 .41578 .40443 .40082 .39361 .39361 .42786 .40024 .38149 .40808 .38573
STD       .06873 .14928 .15382 .14396 .15530 .16704 .16501 .16445 .15041 .14734 .14004 .16288 .14145 .14671 .11931 .15596
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.81), S.S. RESIDUAL:.03738(SD:.01178))
MEAN      .29880 .44221 .39718 .42289 .39828 .38762 .41343 .40151 .39688 .39238 .39597 .42431 .35927 .37907 .40597 .38506
STD       .06876 .14981 .15354 .14006 .15538 .16667 .16461 .16464 .14866 .14862 .14666 .16218 .14871 .14695 .11877 .15594
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.1(SD: 0.33))
MEAN      .29975 .44100 .40096 .42298 .40061 .39002 .41291 .40021 .39472 .39339 .39005 .42351 .40195 .38223 .40693 .38806
STD       .06840 .14307 .14892 .14258 .14802 .16308 .16065 .15954 .14623 .14727 .14350 .15644 .14021 .14523 .11814 .15591
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.38))
MEAN      .29975 .44100 .40096 .42298 .40061 .39002 .41291 .40021 .39472 .39339 .39005 .42351 .40195 .38223 .40693 .38806
STD       .06840 .14307 .14892 .14258 .14802 .16308 .16065 .15954 .14623 .14727 .14350 .15644 .14021 .14523 .11814 .15591
```

```
                                        TABLE A3.129

                                 ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    # SET  9    A=0.30
                                       ---                   --          --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
         ---------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
         ---------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .31297 .49762 .51022 .46164 .50753 .47220 .49209 .49790 .51700 .47055 .49679 .50508 .51156 .48560 .49213 .50239
STD      .07249 .16659 .14063 .14775 .14794 .15175 .14754 .16569 .14798 .14088 .14452 .14479 .15485 .14172 .13474 .14674
         ---------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.67), S.S. RESIDUAL:.04199(SD:.01201))
MEAN     .31052 .49274 .50709 .45794 .50545 .46708 .48779 .49658 .51363 .47523 .49448 .50276 .50066 .48250 .48597 .49909
STD      .07252 .16357 .14015 .14362 .14623 .15129 .14679 .16549 .14887 .14088 .14452 .14359 .15422 .14174 .13227 .14748
         ---------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.7(SD: 0.46))
MEAN     .31276 .48845 .50848 .46094 .50707 .47066 .49044 .50333 .51737 .47915 .49633 .50054 .51069 .48708 .49304 .50288
STD      .07191 .15499 .13982 .15028 .14150 .14638 .14029 .16105 .14073 .13571 .14495 .13412 .15484 .13698 .12379 .15038
         ---------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.32))
MEAN     .31276 .48845 .50848 .46094 .50707 .47066 .49044 .50333 .51737 .47915 .49633 .50054 .51069 .48708 .49304 .50288
STD      .07191 .15499 .13982 .15028 .14150 .14638 .14029 .16105 .14073 .13571 .14495 .13412 .15484 .13698 .12379 .15038


                                        TABLE A3.130

                                 ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    # SET 10    A=0.30
                                       ---                   --          --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
         ---------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
         ---------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .30407 .10369 .13498 .22084 .26305 .29077 .34691 .38281 .44777 .51069 .54699 .58790 .66358 .68638 .80125 .86138
STD      .06762 .08419 .11184 .12464 .13911 .14447 .12316 .14285 .16494 .14173 .15056 .16394 .15794 .13398 .12609 .09761
         ---------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.5(SD: 0.61), S.S. RESIDUAL:.02546(SD:.00845))
MEAN     .30318 .10203 .13392 .22616 .26208 .28972 .34325 .38011 .44797 .51727 .54381 .58637 .66172 .68561 .79977 .86034
STD      .06727 .08218 .10931 .12195 .11809 .14434 .12123 .14807 .16139 .14081 .15118 .16209 .15765 .13236 .12625 .09815
         ---------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.4(SD: 0.49))
MEAN     .30350 .10171 .13549 .22410 .26520 .28626 .34006 .38190 .44051 .51003 .54461 .58771 .66220 .68513 .79703 .85870
STD      .06789 .08142 .10725 .11798 .11907 .14068 .12171 .13474 .16044 .14103 .14781 .16342 .15909 .11361 .12842 .09837
         ---------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.55))
MEAN     .30350 .10171 .13549 .22410 .26520 .28626 .34006 .38190 .44051 .51003 .54461 .58771 .66227 .68513 .79703 .85870
STD      .06789 .08142 .10725 .11798 .11907 .14068 .12171 .13474 .16044 .14103 .14781 .16342 .15909 .11361 .12842 .09837
```

TABLE A3.111

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 B SET 11 A=0.30

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.30	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.05	0.15	0.25	0.35	0.45	0.25
	(SPEARMAN, # OF REP: 100)															
MEAN	.30857	.10972	.13250	.21007	.26299	.31073	.32712	.40600	.43225	.51160	.04027	.14220	.23780	.35678	.45301	.24012
STD	.07427	.08813	.10092	.12747	.11797	.13108	.14449	.14749	.15243	.14432	.07209	.10464	.11903	.11907	.14938	.11315
	(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.59), S.S. RESIDUAL:.0226(SD:.00726))															
MEAN	.30839	.10931	.13204	.21606	.26230	.31094	.32647	.40478	.43142	.51120	.04005	.14224	.23748	.35604	.45377	.24724
STD	.07421	.08701	.09996	.12637	.13731	.13047	.14312	.14714	.15223	.14420	.07139	.10439	.11709	.13715	.14009	.11206
	(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.14))															
MEAN	.30875	.10727	.13116	.21694	.26291	.31129	.32954	.40391	.43423	.51109	.04041	.14377	.24133	.35936	.45545	.24772
STD	.07372	.08214	.09825	.12412	.13469	.13004	.14190	.14641	.15012	.14369	.07104	.10522	.11541	.11763	.14709	.11000
	(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.36))															
MEAN	.30875	.10727	.13116	.21694	.26291	.31129	.32954	.40391	.43523	.51109	.04041	.14377	.24133	.35936	.45545	.24772
STD	.07372	.08214	.09825	.12412	.13469	.13004	.14190	.14641	.15012	.14369	.07104	.10522	.11541	.11763	.14709	.11000

TABLE A3.112

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 B SET 12 A=0.30

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.30	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.95	0.05	0.75	0.65	0.55	0.75
	(SPEARMAN, # OF REP: 100)															
MEAN	.29961	.90541	.86492	.77499	.77556	.68419	.64585	.57706	.55265	.48376	.94927	.05026	.75219	.66029	.55397	.74096
STD	.07354	.08701	.10291	.13137	.11070	.14110	.14462	.16077	.17014	.14508	.07641	.09952	.13701	.15102	.17029	.11704
	(MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.79), S.S. RESIDUAL:.02739(SD:.00702))															
MEAN	.29205	.90172	.85766	.77338	.76915	.67191	.63451	.56559	.54996	.46938	.94319	.05449	.74405	.65666	.53932	.73110
STD	.08212	.08875	.10721	.12713	.13361	.14490	.14379	.16736	.16974	.15229	.07679	.09907	.13510	.15963	.17496	.13959
	(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.6(SD: 0.86))															
MEAN	.29903	.90196	.86094	[illegible]	.77067	.68638	.64129	.57400	.56070	.48544	.94569	.05776	.74311	.66091	.54565	.73293
STD	.07616	.08376	.10252	.12137	.11638	.13268	.13733	.15481	.15767	.12981	.07005	.09569	.11014	.14930	.16570	.13107
	(NEWTON-RAPHSON, # OF REP: 98, AVE # OF ITERATIONS: 6.9(SD: 1.37))															
MEAN	.30267	.90166	.86040	.77500	.77415	.68489	.64254	.57767	.56200	.49142	[illegible]	.05014	.74556	.66490	.59409	.73219
STD	.07516	.08169	.10139	.11412	.11443	.13001	.13659	.15519	.15662	.12676	.07011	.09462	.13097	.14036	.16307	.12960

```
                                        TABLE A3.133

                                   ESTIMATION OF PARAMETERS FOR         B SET  1      A=0.50
                        NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10                 ----
                                           ---                     --           --
                                                                                       B      B      B      B      B
                                                                 B       B       B        B      B      B      B      B      B      B
PARAMETER  A      B      B      B      B      B      B      B       8       9       10     11     12     13     14     15
                   1      2      3      4      5      6      7
------------------------------------------------------------------------------------------------------------------------
VALUES     0.50   0.20   0.20   0.20   0.20   0.20   0.20   0.20    0.20    0.20    0.20    .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .49054 .21417 .20539 .19142 .19460 .18865 .20891 .20022 .19391 .20830 .21901 .      .      .      .      .
STD        .07501 .08312 .09066 .09042 .09620 .10205 .08681 .08800 .09305 .08777 .08608 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.1(SD: 0.51)), S.S. RESIDUAL:.01057(SD:.00362))
MEAN       .49021 .21372 .20478 .19125 .19429 .18021 .20872 .19959 .19154 .20749 .21877 .      .      .      .      .
STD        .07500 .08325 .09064 .09013 .09608 .10186 .08641 .08793 .09279 .08749 .08631 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.14))
MEAN       .49025 .21110 .20381 .19136 .19553 .18061 .20974 .20071 .19421 .20504 .21603 .      .      .      .      .
STD        .07570 .08165 .09801 .09690 .09487 .10097 .08583 .08753 .09121 .08725 .08532 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.31))
MEAN       .49025 .21110 .20381 .19136 .19553 .18061 .20974 .20071 .19421 .20504 .21603 .      .      .      .      .
STD        .07570 .08165 .09801 .09690 .09487 .10097 .08583 .08753 .09121 .08725 .08532 .      .      .      .      .
```

```
                                        TABLE A3.134

                                   ESTIMATION OF PARAMETERS FOR         B SET  2      A=0.50
                        NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10                 ----
                                           ---                     --           --
                                                                                       B      B      B      B      B
                                                                 B       B       B        B      B      B      B      B      B      B
PARAMETER  A      B      B      B      B      B      B      B       8       9       10     11     12     13     14     15
                   1      2      3      4      5      6      7
------------------------------------------------------------------------------------------------------------------------
VALUES     0.50   0.40   0.40   0.40   0.40   0.40   0.40   0.40    0.40    0.40    0.40    .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .50215 .40139 .40360 .42055 .39001 .38771 .39353 .39733 .41021 .38631 .38099 .      .      .      .      .
STD        .08246 .11993 .12520 .11671 .11320 .11709 .10983 .11263 .11881 .11513 .11207 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.63)), S.S. RESIDUAL:.02521(SD:.00725))
MEAN       .50067 .39985 .40213 .42011 .38713 .38573 .39251 .39540 .40806 .38437 .37941 .      .      .      .      .
STD        .08239 .11901 .12542 .11647 .11201 .11709 .10962 .11225 .11703 .11327 .11211 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.27))
MEAN       .50204 .39796 .40404 .42521 .38190 .38580 .39686 .39449 .40966 .38832 .37912 .      .      .      .      .
STD        .08201 .11108 .12419 .11105 .10806 .11705 .10719 .11298 .11661 .10825 .10733 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.30))
MEAN       .50205 .39796 .40404 .42521 .38190 .38580 .39686 .39449 .40966 .38832 .37912 .      .      .      .      .
STD        .08201 .11108 .12419 .11105 .10806 .11705 .10719 .11298 .11661 .10825 .10733 .      .      .      .      .
```

```
                                        TABLE A3.135

                                 ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    E SET  1    A=0.50
                                      ---                   --          --      ----

PARAMETER  A      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51305 .49523 .49200 .49066 .49286 .50372 .50640 .51093 .51356 .49510 .49740 .      .      .      .      .
STD       .08069 .10909 .12085 .12103 .11237 .12065 .12547 .12301 .12331 .12257 .12377 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.50), S.S. RESIDUAL:.02752(SD:.00775))
MEAN      .51006 .49293 .48929 .49461 .49030 .50299 .50465 .50875 .50917 .49391 .49516 .      .      .      .      .
STD       .08137 .10751 .12146 .11970 .13026 .11859 .12293 .12356 .12245 .12071 .12202 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.53))
MEAN      .51101 .49311 .49036 .49512 .49310 .50105 .50750 .50872 .50705 .49243 .49927 .      .      .      .      .
STD       .07845 .10101 .12056 .11553 .12650 .11597 .12200 .12049 .12021 .11607 .11564 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.37))
MEAN      .51101 .49311 .49036 .49512 .49310 .50105 .50750 .50872 .50705 .49243 .49927 .      .      .      .      .
STD       .07845 .10101 .12056 .11553 .12650 .11597 .12200 .12049 .12021 .11607 .11564 .      .      .      .      .


                                        TABLE A3.136

                                 ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    E SET  4    A=0.50
                                      ---                   --          --      ----

PARAMETER  A      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50539 .09150 .15672 .22057 .23537 .31771 .39601 .51100 .70197 .80153 .86067 .      .      .      .      .
STD       .07655 .06000 .08489 .10281 .10331 .12030 .09659 .10120 .10067 .09444 .06901 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.60), S.S. RESIDUAL:.01932(SD:.00973))
MEAN      .50472 .09107 .15578 .21027 .23357 .31686 .39601 .51006 .70193 .80104 .86036 .      .      .      .      .
STD       .07673 .05876 .08145 .10112 .10367 .11962 .09357 .10012 .10168 .09348 .06819 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.35))
MEAN      .50626 .09458 .16022 .21936 .23611 .31551 .39760 .51165 .70230 .80197 .85990 .      .      .      .      .
STD       .07698 .05776 .08175 .10051 .10221 .11479 .09174 .09011 .10211 .09155 .06778 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.51))
MEAN      .50625 .09457 .16020 .21914 .23630 .31549 .39766 .51164 .70217 .80197 .85990 .      .      .      .      .
STD       .07698 .05776 .08174 .10051 .10220 .11479 .09374 .09032 .10212 .09155 .06778 .      .      .      .      .
```

TABLE A3.137

```
                              ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     A SET  5     B=0.50
                              ---                    --            --      ----

PARAMETER  B      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
-----------------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45   .      .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51446 .34594 .24302 .40554 .22349 .09593 .04813 .49290 .31428 .14565 .46103 .      .      .      .
STD       .08567 .09936 .09726 .11592 .10616 .06848 .04904 .11662 .09813 .08596 .10801 .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.50), S.S. RESIDUAL:.01530(SD:.00549))
MEAN      .51420 .34574 .24347 .40450 .22238 .09524 .04822 .49260 .31307 .14570 .46130 .      .      .      .
STD       .08540 .10000 .09616 .11569 .10524 .05922 .05000 .11563 .09750 .08497 .10702 .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.99))
MEAN      .51450 .34053 .24401 .40565 .21794 .09500 .04806 .49383 .31331 .14605 .46106 .      .      .      .
STD       .08544 .09871 .09615 .11632 .10271 .05723 .05021 .11105 .09640 .08188 .10611 .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS. 5.1(SD: 0.41))
MEAN      .51450 .34052 .24401 .40565 .21794 .09500 .04808 .49383 .31331 .14604 .46105 .      .      .      .
STD       .08544 .09871 .09615 .11632 .10271 .05723 .05021 .11105 .09640 .08188 .10611 .      .      .      .
```

TABLE A3.138

```
                              ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     A SET  6     B=0.50
                              ---                    --            --      ----

PARAMETER  B      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
-----------------------------------------------------------------------------------------------------------------------
VALUES    0.50   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55   .      .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50406 .64540 .75220 .61040 .80077 .89759 .95653 .49093 .70270 .84808 .54546 .      .      .      .
STD       .08843 .13017 .11919 .12254 .10132 .06002 .04458 .12046 .12510 .09385 .12360 .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 9.2(SD: 1.95), S.S. RESIDUAL:.01350(SD:.00451))
MEAN      .49363 .64163 .74601 .60102 .79555 .89183 .95337 .48546 .69848 .84275 .53546 .      .      .      .
STD       .08776 .12343 .11501 .12272 .10024 .06341 .04496 .11644 .12203 .08882 .12331 .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  99, AVE # OF ITERATIONS: 7.7(SD: 2.05))
MEAN      .49957 .64360 .74714 .60566 .79987 .88966 .95543 .48525 .69914 .84412 .54384 .      .      .      .
STD       .08319 .11461 .10343 .11041 .09553 .06597 .04202 .10901 .11196 .08243 .10965 .      .      .      .
-----------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  86, AVE # OF ITERATIONS: 8.8(SD: 3.04))
MEAN      .51109 .64576 .74761 .60636 .79506 .88788 .95075 .49276 .69537 .84302 .54682 .      .      .      .
STD       .08360 .11311 .10140 .11059 .08752 .06327 .04191 .11516 .10946 .07748 .10498 .      .      .      .
```

```
                                         TABLE A3.139

                                  ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  40      NUMBER OF ITEMS 15      # SET  7     R=0.50
                                ---                     --             --     ----
PARAMETER  R       R       R       R       R       R       R       R       R       R       R       R       R       R       R
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ----------------------------------------------------------------------------------------------------------------------
VALUES     0.50    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
           ----------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .49206 .19594 .19603 .20016 .19812 .19947 .20662 .19810 .21706 .20345 .20341 .19686 .20986 .20692 .17485 .19935
STD        .07167 .09815 .08087 .09274 .07936 .08837 .09253 .09041 .09505 .08951 .08129 .09051 .08966 .09129 .08281 .08637
           ----------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.0(SD: 0.52), S.S. RESIDUAL:.02767(SD:.00769))
MEAN       .49264 .19564 .19661 .20032 .19702 .19921 .20635 .19802 .21603 .23291 .20307 .19760 .20960 .20662 .19221 .19920
STD        .07160 .09768 .08094 .09276 .07962 .08811 .09204 .09040 .09475 .08900 .08313 .09013 .08940 .09110 .08262 .08625
           ----------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN       .49250 .19609 .19702 .20166 .19810 .19893 .20471 .19890 .21620 .20136 .20145 .19766 .20959 .20622 .19018 .19970
STD        .07120 .09564 .08079 .09254 .07976 .08610 .09060 .09152 .09341 .08771 .08282 .09018 .08845 .09051 .08163 .08454
           ----------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.20))
MEAN       .49250 .19609 .19702 .20166 .19810 .19893 .20471 .19890 .21620 .20136 .20145 .19766 .20959 .20622 .19018 .19970
STD        .07120 .09564 .08079 .09254 .07976 .08610 .09060 .09152 .09341 .08771 .08282 .09018 .08845 .09051 .08163 .08454


                                         TABLE A3.140

                                  ESTIMATION OF PARAMETERS FOR
            NUMBER OF SUBJECTS  40      NUMBER OF ITEMS 15      # SET  8     R=0.50
                                ---                     --             --     ----
PARAMETER  R       R       R       R       R       R       R       R       R       R       R       R       R       R       R
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ----------------------------------------------------------------------------------------------------------------------
VALUES     0.50    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
           ----------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .49539 .38511 .38499 .40478 .39022 .40669 .40144 .39671 .40455 .39470 .40683 .40792 .39479 .40507 .43221 .39266
STD        .07883 .11394 .11973 .11969 .11565 .10489 .11272 .11187 .11063 .11568 .10283 .11067 .10817 .10591 .10016 .11502
           ----------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.60), S.S. RESIDUAL:.06241(SD:.01354))
MEAN       .49402 .38372 .38361 .40311 .39728 .40536 .39808 .39534 .40302 .39344 .40509 .40735 .39412 .40444 .43093 .39018
STD        .07802 .11432 .11940 .13410 .11535 .10428 .11203 .11202 .11054 .11521 .10248 .11060 .10835 .10602 .10102 .11435
           ----------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.10))
MEAN       .49550 .38906 .38557 .40442 .39952 .40765 .39647 .39630 .40534 .39363 .40702 .40789 .39992 .40565 .43281 .39010
STD        .07780 .10860 .11167 .12974 .11228 .10263 .11084 .11180 .10749 .11308 .09514 .10929 .10727 .10305 .10013 .11275
           ----------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.10))
MEAN       .49550 .38906 .38557 .40442 .39952 .40765 .39647 .39630 .40534 .39363 .40702 .40789 .39992 .40565 .43281 .39010
STD        .07780 .10860 .11167 .12974 .11228 .10263 .11084 .11180 .10749 .11308 .09514 .10929 .10727 .10305 .10013 .11275
```

```
                                   TABLE A3.141

                          ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    X SET  9    A=0.50
                                 ---                   --          --    ----

PARAMETER  A        X       X       X       X       X       X       X       X       X       X       X       X       X       X       X
                     1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .51137 .48146 .49966 .49439 .48070 .50911 .51108 .49366 .49069 .51459 .48197 .50250 .48445 .50092 .50127 .49029
STD       .06074 .12299 .11776 .12705 .10966 .11531 .11758 .10715 .11108 .10910 .12521 .12360 .12677 .12636 .11963 .12642
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.47), S.S. RESIDUAL:.06300(SD:.01473))
MEAN      .50000 .47858 .49722 .49193 .48666 .50701 .51065 .49150 .48775 .51042 .47912 .49971 .48127 .49914 .49823 .48011
STD       .06013 .12260 .11764 .12678 .10914 .11489 .11734 .10690 .11139 .10828 .12537 .12346 .12651 .12519 .11802 .12560
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.41))
MEAN      .51176 .48214 .49034 .49421 .48060 .50934 .51038 .49352 .49565 .51125 .47720 .50079 .48796 .50747 .49903 .49260
STD       .06030 .12062 .11395 .11915 .10627 .11067 .10875 .10133 .10480 .10542 .12206 .11943 .12015 .11961 .11145 .12020
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.27))
MEAN      .51176 .48214 .49034 .49421 .48060 .50934 .51038 .49352 .49505 .51125 .47720 .50079 .48796 .50747 .49903 .49260
STD       .06030 .12062 .11395 .11915 .10627 .11067 .10875 .10133 .10480 .10542 .12206 .11943 .12015 .11961 .11345 .12020
```

```
                                   TABLE A3.142

                          ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    X SET 10    A=0.50
                                 ---                   --          --    ----

PARAMETER  A        X       X       X       X       X       X       X       X       X       X       X       X       X       X       X
                     1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.70    0.80    0.85
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50057 .09257 .14006 .18591 .23133 .27955 .34931 .39131 .43634 .50340 .52769 .60000 .65781 .68204 .80766 .85579
STD       .00591 .06653 .07074 .08599 .09877 .10069 .11096 .10080 .11014 .12064 .11524 .11308 .10675 .11343 .09592 .08251
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.63)), S.S. RESIDUAL:.04216(SD:.01312))
MEAN      .49950 .09224 .14001 .18435 .22965 .27850 .34875 .39054 .43558 .50269 .52631 .60691 .65770 .68617 .80595 .85417
STD       .00519 .06562 .07841 .08669 .09739 .10911 .11003 .09950 .10821 .11903 .11395 .11228 .10536 .11163 .09596 .08292
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.33))
MEAN      .50050 .09544 .14205 .18579 .23167 .28024 .34911 .39144 .43431 .50312 .52616 .60674 .65050 .68710 .80520 .85521
STD       .00491 .06707 .07876 .08596 .09516 .10760 .10742 .09019 .10060 .11961 .11072 .11070 .10465 .11235 .09612 .08132
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.45))
MEAN      .50050 .09544 .14205 .18579 .23167 .28024 .34910 .39144 .43431 .50312 .52616 .60674 .65849 .68710 .80520 .85521
STD       .00491 .06707 .07876 .08596 .09516 .10760 .10742 .09019 .10060 .11961 .11072 .11070 .10465 .11235 .09612 .08132
```

```
                                   TABLE A3.143

                           ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 15     B SET 11     R=0.50
                              ---                    --           --     ----

PARAMETER  R     B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.50  0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50167 .10366 .17000 .16470 .21846 .29565 .35686 .39903 .43694 .47595 .04837 .14732 .24943 .35339 .46183 .24593
STD       .00766 .06532 .00799 .00322 .09409 .10025 .10716 .11175 .11114 .11064 .04964 .00357 .08935 .10197 .10005 .09020
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.63)), S.S. RESIDUAL:.03009(SD:.01092))
MEAN      .50144 .10307 .13052 .14414 .13005 .29581 .35545 .39063 .43660 .47636 .04064 .14673 .24890 .35409 .46059 .24527
STD       .00766 .06475 .00775 .00201 .09402 .10769 .10632 .11139 .11099 .11069 .04904 .00601 .08934 .10104 .10023 .08960
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .50175 .10151 .17095 .18554 .21770 .29953 .35254 .39829 .43675 .47986 .04931 .14631 .25193 .35439 .46009 .24980
STD       .00742 .06200 .00620 .00156 .09190 .10602 .10495 .11072 .11052 .11700 .05032 .00613 .08775 .10056 .09904 .08866
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.33))
MEAN      .50175 .10151 .17095 .18554 .21770 .29953 .35254 .39829 .43675 .47986 .04931 .14631 .25193 .35439 .46009 .24980
STD       .00742 .06200 .00620 .00156 .09190 .10602 .10495 .11072 .11052 .11700 .05032 .00613 .08775 .10056 .09904 .08866


                                   TABLE A3.144

                           ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 15     B SET 12     R=0.50
                              ---                    --           --     ----

PARAMETER  R     B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.50  0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.05   0.75   0.65   0.55   0.75
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49456 .89676 .86080 .80916 .75407 .70355 .66797 .60660 .55306 .48791 .94450 .05565 .74693 .66340 .56727 .74805
STD       .00617 .07030 .00533 .09865 .09535 .10052 .10306 .12331 .12290 .12160 .05609 .00316 .12216 .11260 .13103 .11167
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 0.64)), S.S. RESIDUAL:.03612(SD:.00996))
MEAN      .48502 .89172 .85677 .80305 .75040 .69753 .65072 .60129 .54201 .48111 .94080 .05144 .74160 .65553 .55904 .74262
STD       .00602 .06993 .00323 .09866 .09357 .10001 .10057 .11979 .12206 .12116 .05779 .07979 .11986 .10700 .11260 .11070
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.73))
MEAN      .49470 .89430 .85015 .80401 .75416 .70050 .66013 .61110 .55307 .49352 .94136 .05541 .74760 .65077 .56930 .74725
STD       .00026 .06669 .00206 .09370 .08016 .09009 .09275 .11595 .11796 .11990 .05546 .07203 .11302 .09956 .12236 .10169
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 6.3(SD: 0.05))
MEAN      .49670 .89461 .85074 .80470 .75520 .70165 .66150 .61260 .55476 .49555 .94144 .05593 .74873 .66000 .57105 .74824
STD       .00015 .06654 .00174 .09352 .08768 .09740 .09266 .11586 .11794 .11911 .05540 .07260 .11342 .09942 .12213 .10110
```

```
                                        TABLE A3.145

                                 ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    E SET  1    A=0.70
                                    ---                   --          --    ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          --------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70361 .20191 .19927 .19299 .19513 .18579 .20443 .20591 .19691 .20051 .20894 .       .       .       .       .
STD       .06097 .07753 .06906 .07241 .07757 .06574 .08117 .07695 .08220 .08479 .07690 .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.46), S.S. RESIDUAL:.01554(SD:.00422))
MEAN      .70135 .20156 .19901 .19200 .19601 .18566 .20424 .20566 .19636 .20023 .20068 .       .       .       .       .
STD       .06806 .07740 .06800 .07217 .07739 .06557 .08116 .07893 .08215 .08454 .07681 .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (GUNDMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .70300 .20477 .19762 .19126 .19320 .18660 .20333 .20524 .19605 .19981 .20039 .       .       .       .       .
STD       .06911 .07715 .06834 .07318 .07678 .06545 .08100 .07820 .07920 .08157 .07633 .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.27))
MEAN      .70300 .20477 .19762 .19126 .19320 .18660 .20333 .20524 .19605 .19981 .20039 .       .       .       .       .
STD       .06911 .07715 .06834 .07318 .07678 .06545 .08100 .07820 .07920 .08157 .07633 .       .       .       .       .


                                        TABLE A3.146

                                 ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    E SET  2    A=0.70
                                    ---                   --          --    ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          --------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70362 .39719 .39763 .40986 .40548 .39657 .40134 .38955 .39290 .40462 .38789 .       .       .       .       .
STD       .07519 .09192 .10337 .08360 .09762 .10126 .10009 .10292 .09546 .09177 .10036 .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.40), S.S. RESIDUAL:.03591(SD:.00961))
MEAN      .70135 .39562 .39652 .40815 .40362 .39476 .40131 .38013 .39187 .40240 .38694 .       .       .       .       .
STD       .07555 .09121 .10191 .08111 .09655 .10042 .09969 .10188 .09542 .09103 .09977 .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (GUNDMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.25))
MEAN      .70157 .39662 .40200 .40952 .40522 .39536 .40011 .39064 .39209 .40262 .38980 .       .       .       .       .
STD       .07203 .08818 .09573 .07867 .09061 .09697 .09669 .09786 .09436 .08822 .09735 .       .       .       .       .
          --------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.35))
MEAN      .70157 .39662 .40200 .40952 .40522 .39536 .40011 .39064 .39209 .40262 .38980 .       .       .       .       .
STD       .07203 .08818 .09573 .07867 .09061 .09697 .09669 .09786 .09436 .08822 .09735 .       .       .       .       .
```

```
                                              TABLE A3.147

                                     ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    # SET  1    A=0.70
                                         ---                    --          --    ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
------------------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69306 .49096 .51222 .49520 .49590 .49778 .48964 .48345 .50320 .50032 .49811 .      .      .      .      .
STD       .06966 .09524 .10324 .09460 .09444 .09665 .09079 .10446 .09959 .09606 .10342 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (HINKS, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.51), S.S. RESIDUAL:.03945(SD:.00908))
MEAN      .69132 .48907 .50952 .49356 .49462 .49640 .48883 .48813 .50737 .50659 .49568 .      .      .      .      .
STD       .06881 .09466 .10136 .09777 .09274 .09584 .09865 .10409 .09874 .09538 .10152 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.7(SD: 0.50))
MEAN      .69591 .49296 .50851 .49625 .50122 .50196 .49103 .48212 .50760 .50725 .49914 .      .      .      .      .
STD       .06517 .09371 .09500 .09442 .08951 .09251 .09693 .10595 .09803 .09388 .10112 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.8(SD: 0.39))
MEAN      .69591 .49296 .50851 .49625 .50122 .50196 .49103 .48212 .50760 .50725 .49914 .      .      .      .      .
STD       .06517 .09371 .09500 .09442 .08951 .09251 .09693 .10595 .09803 .09388 .10112 .      .      .      .      .


                                              TABLE A3.148

                                     ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    # SET  4    A=0.70
                                         ---                    --          --    ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
------------------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .71615 .10220 .15056 .19814 .26013 .30213 .40154 .47636 .69436 .79960 .85941 .      .      .      .      .
STD       .07471 .05158 .07028 .07771 .09020 .08765 .08174 .09314 .08813 .07931 .06534 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (HINKS, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.58), S.S. RESIDUAL:.02018(SD:.00573))
MEAN      .71563 .10243 .15002 .19925 .25793 .30036 .40056 .47650 .69415 .79940 .85027 .      .      .      .      .
STD       .07421 .05137 .06908 .07844 .08774 .08710 .08197 .09305 .08612 .07848 .06391 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.8(SD: 0.40))
MEAN      .71527 .10147 .14949 .20048 .25557 .29927 .39965 .47784 .69576 .80019 .85725 .      .      .      .      .
STD       .07168 .04900 .06521 .07716 .08523 .08255 .07829 .09474 .08473 .07660 .06376 .      .      .      .      .
------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.[illegible](SD: 0.47))
MEAN      .71526 .10147 .14948 .20048 .25557 .29926 .39985 .47784 .69576 .80019 .85724 .      .      .      .      .
STD       .07167 .04900 .06522 .07716 .08523 .08255 .07830 .09474 .08473 .07660 .06376 .      .      .      .      .
```

```
                                          TABLE A3.149

                                   ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    E SET  5    K=0.70
                                         ---                   --          --    ----

PARAMETER  K       E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69767 .34984 .27400 .38459 .17619 .10121 .05196 .46823 .27629 .14782 .44400 .      .      .      .      .
STD       .07379 .08750 .08292 .09334 .07010 .05649 .04000 .10074 .09154 .06366 .08953 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.7(SD: 0.60), S.S. RESIDUAL:.02004(SD:.00656))
MEAN      .69696 .34897 .27332 .38373 .17629 .10035 .05121 .46673 .27600 .14733 .44391 .      .      .      .      .
STD       .07176 .08311 .08200 .09293 .06923 .05685 .03955 .10044 .09060 .06690 .08065 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.2(SD: 0.38))
MEAN      .69725 .34835 .27216 .38284 .17763 .09910 .05170 .46493 .27850 .14742 .44519 .      .      .      .      .
STD       .07427 .08676 .07984 .09120 .06317 .05523 .03867 .09735 .09197 .06657 .08625 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.37))
MEAN      .69725 .34835 .27215 .38287 .17765 .09910 .05170 .46493 .27850 .14747 .44519 .      .      .      .      .
STD       .07427 .08476 .07904 .09120 .06317 .05522 .03867 .09735 .09197 .06657 .08625 .      .      .      .      .


                                          TABLE A3.150

                                   ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    E SET  6    K=0.70
                                         ---                   --          --    ----

PARAMETER  K       E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .73417 .64733 .75971 .59825 .80534 .90494 .95003 .51370 .70196 .85167 .55090 .      .      .      .      .
STD       .09662 .10249 .08857 .11944 .08235 .05934 .03987 .10546 .08956 .07200 .10350 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.6(SD: 1.32), S.S. RESIDUAL:.02003(SD:.00676))
MEAN      .69804 .63989 .75397 .58930 .80133 .90050 .94594 .50703 .69596 .84608 .54295 .      .      .      .      .
STD       .09373 .09703 .08607 .11426 .08030 .05649 .04119 .10229 .08675 .06760 .09932 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 8.5(SD: 1.67))
MEAN      .70607 .64377 .75577 .59392 .80514 .90104 .94421 .51007 .70048 .84861 .54645 .      .      .      .      .
STD       .08695 .08755 .07918 .10032 .07450 .05443 .03988 .09744 .08094 .06465 .09402 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  96, AVE # OF ITERATIONS: 7.0(SD: 2.03))
MEAN      .69990 .64760 .75601 .59441 .80447 .89997 .94105 .51147 .70179 .84896 .54007 .      .      .      .      .
STD       .11176 .08761 .07870 .10070 .07601 .10591 .01912 .09533 .08001 .06451 .09435 .      .      .      .      .
```

```
                                              TABLE A3.151

                                      ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 15     B SET  7     R=0.70
                                          ---                    --            --      ----

PARAMETER  R       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES     0.70    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .71109 .20100 .18958 .19990 .20319 .18769 .20554 .19893 .19496 .19527 .20457 .19790 .20719 .19926 .20726 .19062
STD       .07579 .07657 .07736 .07874 .07166 .07220 .07707 .07571 .07494 .07192 .07446 .07950 .08115 .07549 .07969 .07038
          ------------------------------------------------------------------------------------------------------------------------------
          (GIBBES, # OF REP: 100, AVE # OF ITERATIONS 5.7(SD: 0.53), S.S. RESIDUAL: .04016(SD: .00050))
MEAN      .71089 .20090 .18931 .19968 .20207 .18740 .20524 .19886 .19476 .19517 .20459 .19767 .20706 .19900 .20703 .19047
STD       .07576 .07691 .07739 .07850 .07163 .07211 .07705 .07570 .07491 .07181 .07442 .07935 .08100 .07551 .07942 .07027
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .71050 .19952 .18983 .19969 .20192 .18643 .20580 .19069 .19391 .19475 .20386 .19637 .20670 .19873 .20672 .19075
STD       .07539 .07686 .07752 .07727 .07022 .07076 .07504 .07660 .07392 .07210 .07293 .07811 .08102 .07622 .07767 .06766
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.20))
MEAN      .71050 .19952 .18983 .19969 .20192 .18643 .20580 .19069 .19391 .19475 .20386 .19637 .20670 .19873 .20672 .19075
STD       .07539 .07686 .07752 .07727 .07022 .07076 .07504 .07660 .07392 .07210 .07293 .07811 .08102 .07622 .07767 .06766


                                              TABLE A3.152

                                      ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 15     B SET  8     R=0.70
                                          ---                    --            --      ----

PARAMETER  R       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES     0.70    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .71713 .41167 .40972 .38809 .39307 .39977 .40651 .41236 .40297 .40600 .39396 .40263 .40601 .39638 .38056 .42505
STD       .06917 .09456 .10091 .10016 .09311 .09689 .09294 .08989 .09563 .10063 .08895 .10399 .09553 .11141 .09857 .09151
          ------------------------------------------------------------------------------------------------------------------------------
          (GIBBES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.61), S.S. RESIDUAL: .09154(SD: .01892))
MEAN      .71584 .41074 .40405 .38692 .39173 .39233 .40541 .41140 .40234 .40624 .39333 .40145 .40490 .39516 .38808 .42195
STD       .06924 .09469 .10097 .10009 .09258 .09685 .09264 .08943 .09508 .10026 .08875 .10395 .09508 .11066 .09843 .09105
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.17))
MEAN      .71700 .41191 .40289 .38919 .39241 .40063 .40466 .41257 .40432 .40630 .39042 .40350 .40573 .39578 .39008 .42495
STD       .06843 .09144 .09871 .09946 .08990 .09579 .09122 .08127 .09419 .09483 .08792 .10172 .09326 .10964 .08936 .08815
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.34))
MEAN      .71700 .41191 .40289 .38919 .39241 .40063 .40466 .41257 .40432 .40630 .39042 .40350 .40573 .39578 .39008 .42495
STD       .06843 .09144 .09871 .09946 .08990 .09579 .09122 .08127 .09419 .09483 .08792 .10172 .09326 .10964 .08936 .08815
```

TABLE A3.153

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 B SET 9 A=0.70

PARAMETER	A	B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15
VALUES	0.70	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
(SPEARMAN, # OF REP: 100)																
MEAN	.70532	.50950	.49869	.49209	.49647	.49932	.48019	.48804	.50061	.49408	.50176	.49243	.49676	.49705	.49479	.47947
STD	.06618	.09275	.10505	.10130	.09595	.08526	.11546	.09725	.09965	.09409	.09838	.09015	.09531	.10549	.11446	.09850
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.54), S.S. RESIDUAL:.09073(SD:.01073))																
MEAN	.70250	.50727	.49650	.48967	.49489	.49781	.47929	.48718	.49812	.49227	.50149	.49234	.49498	.49592	.49152	.47721
STD	.06603	.09207	.10435	.10094	.09648	.08452	.11441	.09664	.09834	.09471	.09782	.09037	.09488	.10539	.11762	.09071
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.8(SD: 0.40))																
MEAN	.70027	.50054	.49005	.48917	.49633	.50336	.48601	.49169	.50366	.49553	.50350	.49610	.49896	.50020	.49719	.47981
STD	.06733	.08994	.10235	.09440	.09562	.08207	.10793	.09233	.09516	.09031	.09514	.08696	.09444	.10247	.11377	.09749
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.42))																
MEAN	.70027	.50054	.49005	.48917	.49633	.50336	.48601	.49169	.50366	.49553	.50350	.49610	.49896	.50020	.49719	.47981
STD	.06733	.08994	.10235	.09440	.09562	.08207	.10793	.09233	.09516	.09031	.09514	.08696	.09444	.10247	.11377	.09749

TABLE A3.154

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 B SET 10 A=0.70

PARAMETER	A	B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15
VALUES	0.70	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.80	0.85
(SPEARMAN, # OF REP: 100)																
MEAN	.70544	.08757	.14487	.19267	.24948	.29627	.35645	.40001	.45486	.50263	.55255	.58332	.65237	.70023	.78637	.83065
STD	.07240	.05195	.06964	.08365	.09250	.08682	.09535	.09799	.09250	.10588	.09571	.09116	.09972	.08318	.07693	.07220
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.5(SD: 0.56), S.S. RESIDUAL:.06165(SD:.01360))																
MEAN	.70500	.08698	.14515	.19298	.24878	.29609	.35600	.40021	.45350	.50225	.55253	.58269	.65132	.69875	.78516	.83807
STD	.07175	.05217	.06904	.08327	.09145	.08645	.09621	.09726	.09092	.10411	.09525	.09000	.09946	.08305	.07679	.07147
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.26))																
MEAN	.70550	.08570	.14444	.19193	.25024	.29819	.35600	.40032	.45296	.50331	.55306	.58469	.65194	.69884	.78579	.83838
STD	.07048	.05145	.06665	.08184	.08804	.08607	.09741	.09488	.09038	.10332	.09418	.08931	.09757	.08160	.07712	.07044
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.30))																
MEAN	.70550	.08570	.14444	.19193	.25024	.29819	.35600	.40032	.45296	.50331	.55306	.58469	.65194	.69884	.78579	.83838
STD	.07048	.05145	.06665	.08184	.08804	.08607	.09741	.09488	.09038	.10332	.09418	.08931	.09757	.08160	.07712	.07044

TABLE A3.155

```
                          ESTIMATION OF PARAMETERS FOR
     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    # SET 11    A=0.70
                         ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70118 .10429 .15275 .19111 .24207 .29932 .33702 .39772 .43966 .49751 .05278 .15432 .25570 .36720 .45009 .25069
STD       .07669 .05265 .06609 .07729 .09434 .08819 .09106 .09908 .10121 .09374 .04107 .06598 .08781 .09214 .10596 .09093
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.4(SD: 0.63), S.S. RESIDUAL:.05317(SD:.01092))
MEAN      .70094 .10232 .15248 .19355 .24176 .29057 .33658 .39709 .43932 .49683 .05268 .15410 .25600 .36696 .45752 .25050
STD       .07670 .05106 .06555 .07766 .09417 .08812 .09057 .09939 .10162 .09337 .04113 .06566 .08757 .09145 .10559 .09033
          ----------------------------------------------------------------------------------------------------------------
          (GUNDUNAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .70125 .10298 .15143 .19445 .23986 .30069 .33791 .39806 .43794 .49563 .05220 .15463 .25786 .36750 .45749 .25915
STD       .07624 .05180 .06360 .07584 .09259 .08837 .09024 .09911 .10286 .09460 .04044 .06581 .08657 .09101 .10595 .09418
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.20))
MEAN      .70125 .10298 .15143 .19445 .23986 .30069 .33791 .39806 .43794 .49563 .05220 .15463 .25786 .36750 .45749 .25915
STD       .07624 .05180 .06160 .07584 .09259 .08837 .09024 .09911 .10286 .09460 .04044 .06581 .08657 .09101 .10595 .09018
```

TABLE A3.156

```
                          ESTIMATION OF PARAMETERS FOR
     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    # SET 12    A=0.70
                         ---                   --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.05   0.75   0.65   0.55   0.75
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70602 .89992 .84370 .79550 .74252 .70903 .65908 .61052 .55595 .50473 .94839 .04998 .74357 .64689 .56002 .76487
STD       .08139 .05869 .07732 .09511 .09384 .08993 .09022 .09592 .09168 .10040 .03971 .07054 .08228 .09853 .10014 .08590
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.62), S.S. RESIDUAL:.05320(SD:.01249))
MEAN      .70065 .89725 .84120 .79564 .74208 .70706 .65369 .61266 .55140 .50132 .94690 .04953 .74194 .64194 .55746 .76156
STD       .08225 .05766 .07763 .09206 .09277 .08893 .08801 .09355 .09000 .10213 .03955 .07726 .08151 .09709 .10609 .08413
          ----------------------------------------------------------------------------------------------------------------
          (GUNDUNAN, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.67))
MEAN      .70152 .89409 .84170 .80036 .74410 .70519 .65215 .61052 .55010 .50143 .94676 .05107 .74266 .64256 .55019 .76335
STD       .07497 .05710 .07644 .08658 .08793 .08677 .08771 .09149 .08372 .10191 .03925 .07449 .07734 .09194 .09790 .08218
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 6.1(SD: 0.94))
MEAN      .70136 .89509 .84209 .80085 .74472 .70591 .65107 .61156 .55131 .50459 .94682 .05139 .74352 .64341 .55921 .76370
STD       .07510 .05697 .07612 .08649 .08789 .08660 .08752 .09114 .08363 .10238 .03921 .07432 .07715 .09206 .09807 .08248
```

```
                                       TABLE A3.157

                                ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     B SET  1     A=0.75
                                       ---                    --           --       ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -----------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75163 .19062 .17807 .19104 .19208 .19238 .20202 .19730 .19320 .20650 .20101 .       .       .       .       .
STD       .07208 .07595 .07676 .07575 .06792 .06599 .07549 .06825 .07257 .06477 .06245 .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.52), S.S. RESIDUAL:.01660(SD:.00540))
MEAN      .75139 .19036 .17860 .19275 .19194 .19199 .20175 .19725 .19295 .20637 .20077 .       .       .       .       .
STD       .07182 .07570 .07659 .07560 .06789 .06577 .07522 .06817 .07265 .06471 .06236 .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75100 .18949 .17801 .19166 .19176 .19083 .20200 .19640 .19320 .20533 .20167 .       .       .       .       .
STD       .07124 .07421 .07565 .07464 .06890 .06433 .07388 .06699 .07443 .06342 .06311 .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.17))
MEAN      .75100 .18949 .17801 .19166 .19176 .19083 .20200 .19640 .19320 .20533 .20167 .       .       .       .       .
STD       .07124 .07421 .07565 .07464 .06890 .06433 .07388 .06699 .07443 .06342 .06311 .       .       .       .       .


                                       TABLE A3.158

                                ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     B SET  2     A=0.75
                                       ---                    --           --       ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -----------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74315 .38730 .38706 .39833 .40780 .40690 .40083 .40243 .40044 .39143 .41133 .       .       .       .       .
STD       .06643 .08635 .10057 .09944 .10481 .09116 .08706 .09157 .09553 .09610 .08939 .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.49), S.S. RESIDUAL:.09016(SD:.01024))
MEAN      .74193 .38612 .38729 .39704 .40648 .40619 .39555 .40150 .39922 .39132 .41032 .       .       .       .       .
STD       .06620 .08553 .10029 .09913 .10445 .09832 .08722 .09143 .09546 .09649 .08899 .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.26))
MEAN      .74400 .38442 .39165 .39791 .40728 .40901 .40155 .40748 .39903 .39343 .41016 .       .       .       .       .
STD       .06159 .08130 .09704 .10201 .10179 .08626 .08738 .09027 .09649 .09301 .08811 .       .       .       .       .
          -----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.30))
MEAN      .74400 .38442 .39165 .39791 .40728 .40901 .40155 .40748 .39903 .39343 .41016 .       .       .       .       .
STD       .06159 .08130 .09704 .10201 .10179 .08626 .08738 .09027 .09649 .09301 .08811 .       .       .       .       .
```

```
                                      TABLE A3.159

                              ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     B SET  3     A=0.75
                                     ---                    --            --      ----

PARAMETER  A        B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                     1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------------
VALUES     0.75   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .75131 .49170 .48410 .49391 .50407 .50237 .50426 .51775 .49045 .51560 .48151 .      .      .      .      .
STD        .06911 .09298 .10466 .10943 .09504 .09769 .09549 .09100 .09913 .09276 .08641 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.52), S.S. RESIDUAL:.04325(SD:.01151))
MEAN       .74767 .48086 .48067 .49216 .50225 .49970 .50251 .51506 .49639 .51426 .48048 .      .      .      .      .
STD        .06695 .09375 .10169 .10890 .09376 .09541 .09360 .09193 .09992 .09225 .08590 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.48))
MEAN       .75196 .48961 .47960 .49600 .50549 .50011 .50435 .51670 .49726 .51936 .48759 .      .      .      .      .
STD        .06767 .08616 .10010 .10757 .08759 .08699 .08796 .09005 .10078 .09042 .08163 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.49))
MEAN       .75196 .48961 .47960 .49600 .50549 .50011 .50435 .51670 .49726 .51936 .48759 .      .      .      .      .
STD        .06767 .08616 .10010 .10757 .08759 .08699 .08796 .09005 .10078 .09042 .08163 .      .      .      .      .


                                      TABLE A3.160

                              ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     B SET  4     A=0.75
                                     ---                    --            --      ----

PARAMETER  A        B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                     1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           ---------------------------------------------------------------------------------------------------------------
VALUES     0.75   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .75667 .10127 .14695 .20071 .25051 .29663 .40041 .48726 .70797 .80121 .84805 .      .      .      .      .
STD        .07218 .05184 .06417 .07273 .06121 .08639 .09026 .09400 .08750 .07009 .06665 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 0.53), S.S. RESIDUAL:.02112(SD:.00667))
MEAN       .75592 .10285 .14660 .20067 .24941 .29766 .40761 .48550 .70725 .80011 .84608 .      .      .      .      .
STD        .07217 .05252 .06105 .07212 .08001 .08570 .08902 .09204 .08815 .06947 .06677 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.8(SD: 0.40))
MEAN       .75451 .10207 .14274 .20012 .24025 .29518 .40575 .48703 .70583 .79936 .84719 .      .      .      .      .
STD        .07120 .05082 .05981 .06915 .07889 .08536 .08837 .09030 .08810 .07036 .06677 .      .      .      .      .
           ---------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 0.38))
MEAN       .75451 .10207 .14273 .20011 .24025 .29517 .40574 .48702 .70582 .79936 .84719 .      .      .      .      .
STD        .07129 .05081 .05980 .06915 .07884 .08536 .08836 .09031 .08810 .07037 .06677 .      .      .      .      .
```

```
                                          TABLE A3.161

                                  ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     E SET  5     A=0.75
                                    ---                     --            --      ----

PARAMETER  A       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.35    0.25    0.40    0.20    0.10    0.05    0.50    0.30    0.15    0.45     .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74578 .35573 .24068 .39104 .19460 .09954 .05918 .51202 .30708 .14819 .45511 .       .       .       .       .
STD       .06979 .09459 .08022 .09019 .07922 .06195 .04027 .08953 .09407 .07469 .09555 .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.8(SD: 0.51), S.S. RESIDUAL:.02169(SD:.00663))
MEAN      .74560 .35554 .24066 .39056 .19824 .09934 .05911 .51106 .30734 .14750 .45520 .       .       .       .       .
STD       .06944 .09393 .07988 .09013 .07915 .06133 .03912 .08924 .09405 .07410 .09526 .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.2(SD: 0.39))
MEAN      .74575 .35635 .24062 .39040 .19914 .09870 .05909 .51173 .30705 .14612 .45639 .       .       .       .       .
STD       .06900 .09409 .08055 .09015 .07706 .06121 .03862 .08061 .09415 .07256 .09511 .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.39))
MEAN      .74575 .35635 .24062 .39019 .19914 .09870 .05909 .51173 .30705 .14612 .45639 .       .       .       .       .
STD       .06900 .09409 .08055 .09015 .07706 .06121 .03862 .08061 .09415 .07256 .09511 .       .       .       .       .


                                          TABLE A3.162

                                  ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10     E SET  6     A=0.75
                                    ---                     --            --      ----

PARAMETER  A       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ----------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.65    0.75    0.60    0.80    0.90    0.95    0.50    0.70    0.85    0.55     .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75644 .65667 .76347 .59563 .81004 .90736 .95141 .49861 .70473 .84571 .55482 .       .       .       .       .
STD       .08667 .10822 .08404 .09447 .06863 .06062 .04190 .09067 .09493 .06047 .11314 .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.9(SD: 1.65), S.S. RESIDUAL:.02144(SD:.00657))
MEAN      .74530 .65050 .76100 .58929 .80512 .90303 .94950 .48951 .69550 .84179 .55259 .       .       .       .       .
STD       .08406 .10499 .08207 .09245 .06500 .06034 .04163 .08652 .09350 .06069 .10720 .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  98, AVE # OF ITERATIONS: 9.1(SD: 2.01))
MEAN      .75442 .65514 .76533 .59499 .80682 .90568 .95077 .49557 .69535 .84404 .56103 .       .       .       .       .
STD       .07290 .09979 .07635 .08850 .06212 .05804 .03063 .07845 .08883 .06808 .10009 .       .       .       .       .
          ----------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  82, AVE # OF ITERATIONS: 6.7(SD: 2.10))
MEAN      .74733 .65624 .76990 .59160 .80210 .80951 .94229 .49521 .69544 .81509 .55252 .       .       .       .       .
STD       .11006 .09929 .07666 .08827 .05856 .11600 .03484 .07810 .08957 .06657 .09412 .       .       .       .       .
```

```
                                         TABLE A1.163

                                 ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15     # SET  7     A=0.75
                                      ---                   --           --     ----

PARAMETER  A      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                   1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75241 .20125 .20461 .19292 .20517 .19063 .21514 .20062 .19357 .18866 .20609 .19625 .20426 .19466 .20071 .20396
STD       .06157 .08422 .07986 .07050 .06705 .07453 .07451 .08133 .07234 .06926 .07482 .07063 .07793 .07502 .07151 .06843
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.7(SD: 0.54), S.S. RESIDUAL:.04405(SD:.01099))
MEAN      .75225 .20115 .20457 .19203 .20483 .19045 .21498 .20056 .19355 .18856 .20681 .19409 .20405 .19452 .20059 .20300
STD       .06154 .08405 .07991 .07042 .06712 .07441 .07435 .08119 .07231 .06913 .07475 .07033 .07796 .07505 .07352 .06827
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75225 .20063 .20529 .19266 .20456 .19091 .21327 .20080 .19553 .18866 .20647 .19402 .20410 .19516 .20102 .20110
STD       .06156 .08418 .08053 .06949 .06739 .07387 .07292 .08023 .07206 .06928 .07393 .07027 .07773 .07404 .07329 .06702
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.22))
MEAN      .75225 .20063 .20529 .19266 .20456 .19091 .21327 .20080 .19553 .18866 .20647 .19402 .20410 .19516 .20102 .20110
STD       .06156 .08418 .08053 .06949 .06739 .07387 .07292 .08023 .07206 .06928 .07393 .07027 .07773 .07404 .07329 .06702


                                         TABLE A1.164

                                 ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15     # SET  8     A=0.75
                                      ---                   --           --     ----

PARAMETER  A      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                   1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75085 .41691 .40486 .41746 .39720 .39870 .39253 .38049 .39926 .40057 .39308 .39903 .39319 .37530 .41570 .39270
STD       .07141 .09024 .09543 .09900 .09778 .09404 .08570 .08401 .08742 .09271 .09130 .09015 .08406 .09692 .10320 .08017
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.55), S.S. RESIDUAL:.09490(SD:.01931))
MEAN      .74952 .41651 .40300 .41645 .39551 .39817 .39207 .37926 .39397 .39953 .39043 .39920 .39181 .37465 .41459 .39222
STD       .07119 .08969 .09500 .09842 .09731 .09374 .08509 .08331 .08723 .09240 .09140 .09006 .08181 .09550 .10274 .07908
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.24))
MEAN      .75100 .41779 .40508 .41465 .39579 .39833 .39576 .38159 .39545 .39872 .39119 .40052 .39311 .37705 .41199 .39471
STD       .06862 .08804 .09361 .09510 .09920 .09018 .08334 .08204 .08601 .09066 .09189 .09173 .08365 .09396 .10221 .07956
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.42))
MEAN      .75100 .41779 .40508 .41465 .39579 .39833 .39576 .38159 .39545 .39872 .39119 .40052 .39311 .37705 .41199 .39471
STD       .06862 .08804 .09161 .09510 .09920 .09018 .08334 .08204 .08601 .09066 .09189 .09173 .08365 .09396 .10221 .07956
```

```
                                         TABLE A3.165

                                  ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    B SET  9    A=0.75
                                        ---                   --          --    ----

PARAMETER  A      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                   1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
          ------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .76121 .50161 .48619 .49976 .49279 .50061 .51210 .51051 .49571 .48927 .49259 .49520 .49423 .49150 .51590 .50279
STD       .05996 .10252 .08165 .09090 .08412 .08191 .08202 .08455 .08841 .10019 .09095 .09857 .08527 .09555 .09380 .09571
          ------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.53), S.S. RESIDUALS:.10790(SD:.01791))
MEAN      .75896 .50232 .48555 .49277 .49196 .50735 .51000 .51713 .49926 .48674 .49160 .49451 .49250 .49230 .51513 .50097
STD       .05990 .10150 .08173 .09821 .08410 .08101 .08330 .08443 .08808 .09961 .09075 .09810 .08836 .09514 .09429 .09520
          ------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.27))
MEAN      .75927 .50535 .48504 .48875 .49373 .50692 .51161 .51601 .49766 .48845 .49196 .49407 .49000 .49326 .51517 .49923
STD       .05792 .09861 .08083 .09166 .08101 .08814 .08500 .08554 .08568 .09826 .09127 .09770 .07997 .09148 .09208 .09081
          ------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.45))
MEAN      .75927 .50535 .48504 .48875 .49373 .50692 .51161 .51601 .49766 .48845 .49196 .49407 .49000 .49326 .51517 .49923
STD       .05792 .09861 .08083 .09166 .08101 .08814 .08500 .08554 .08568 .09826 .09127 .09770 .07997 .09148 .09208 .09081


                                         TABLE A3.166

                                  ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15    B SET 10    A=0.75
                                        ---                   --          --    ----

PARAMETER  A      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                   1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.70    0.80    0.85
          ------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74234 .10106 .15171 .21122 .25396 .29627 .35174 .39717 .45879 .49562 .55649 .58398 .64863 .69130 .80376 .84932
STD       .07600 .05626 .06139 .07711 .09309 .08826 .09077 .09721 .08947 .09762 .10752 .09418 .08160 .09067 .07267 .06329
          ------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.62), S.S. RESIDUALS:.06447(SD:.01272))
MEAN      .74139 .10108 .15103 .20946 .25295 .29506 .35093 .39632 .45781 .49650 .55542 .58379 .64797 .69201 .80290 .84886
STD       .07461 .05660 .06284 .07560 .09245 .08729 .09855 .09589 .08965 .09608 .10677 .09267 .08148 .08963 .07269 .06700
          ------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.22))
MEAN      .74100 .10153 .15106 .20816 .25101 .29438 .35010 .39359 .45840 .49865 .55555 .58103 .64022 .69110 .80224 .84870
STD       .07147 .05632 .06170 .07460 .09090 .08663 .09816 .09250 .09006 .09460 .10520 .08908 .08031 .08866 .07172 .06020
          ------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.34))
MEAN      .74100 .10151 .15106 .20816 .25101 .29438 .35010 .39359 .45840 .49865 .55555 .58101 .64022 .69110 .80224 .84870
STD       .07147 .05632 .06170 .07460 .09090 .08663 .09816 .09250 .09006 .09460 .10520 .08908 .08031 .08866 .07172 .06020
```

TABLE A3.167

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 B SET 11 A=0.75

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.75	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.05	0.15	0.25	0.35	0.45	0.25
	(SPEARMAN, # OF REP: 100)															
MEAN	.75630	.10459	.14405	.20200	.25223	.30057	.34918	.39733	.45143	.50203	.05056	.13136	.23604	.35707	.4515[illegible]	.24021
STD	.06945	.05957	.06519	.09443	.08922	.07691	.08755	.08114	.10180	.10385	.03761	.06761	.08676	.08114	.09297	.07603
	(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.2(SD: 0.53)), S.S. RESIDUAL:.05765(SD:.01175))															
MEAN	.75602	.10427	.14378	.20208	.25131	.30826	.34383	.39694	.45315	.50198	.05058	.13129	.23573	.35778	.45107	.24022
STD	.06947	.05935	.06499	.09418	.08868	.07636	.08781	.08887	.10150	.10319	.03734	.06752	.08613	.08868	.09280	.07592
	(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))															
MEAN	.75650	.10455	.14419	.20211	.25070	.30957	.34499	.39691	.45248	.50373	.05009	.13173	.23600	.35027	.45055	.24126
STD	.06941	.05805	.06463	.09255	.08737	.07664	.08858	.08838	.10022	.10249	.03709	.06542	.08405	.08111	.09215	.07488
	(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.30))															
MEAN	.75650	.10455	.14419	.20211	.25070	.30957	.34499	.39691	.45248	.50373	.05009	.13173	.23600	.35027	.45055	.24126
STD	.06941	.05805	.06463	.09255	.08737	.07664	.08858	.08838	.10022	.10249	.03709	.06542	.08405	.08111	.09215	.07488

TABLE A3.168

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 B SET 12 A=0.75

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.75	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.95	0.05	0.75	0.65	0.55	0.75
	(SPEARMAN, # OF REP: 100)															
MEAN	.74308	.90608	.83620	.79463	.74632	.69299	.65049	.61744	.55364	.50105	.95492	.05654	.76411	.65613	.54695	.74948
STD	.06538	.05806	.06198	.07817	.08309	.09402	.09698	.08349	.09580	.09519	.03995	.06408	.08206	.10008	.09231	.08622
	(MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.55)), S.S. RESIDUAL:.05704(SD:.01330))															
MEAN	.73445	.90558	.83266	.79293	.74347	.68781	.64647	.61038	.55052	.49781	.95311	.05428	.76065	.65196	.54280	.74553
STD	.06403	.05622	.05999	.07758	.08304	.09278	.09298	.08262	.09542	.09289	.03974	.06165	.08327	.09563	.09098	.08448
	(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.61))															
MEAN	.74196	.90754	.83537	.79524	.74506	.68883	.64905	.61357	.55193	.50234	.95344	.05550	.75964	.65485	.54495	.74869
STD	.06304	.05118	.05694	.07612	.08194	.08627	.09805	.07875	.08826	.08641	.03777	.05936	.07977	.09308	.08727	.07722
	(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 6.0(SD: 0.90))															
MEAN	.74305	.90776	.83578	.79571	.74656	.68960	.64989	.61457	.55306	.50756	.95346	.05509	.76015	.65561	.54511	.74935
STD	.06261	.05104	.05684	.07611	.08159	.08620	.09010	.07832	.08821	.08654	.03775	.05916	.07995	.09323	.08712	.07704

```
                                        TABLE A3.169

                                ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    # SET  1    R=0.00
                                         ---                   --          --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00677 .20625 .19402 .20809 .20646 .19829 .20420 .20029 .20310 .19106 .20102 .      .      .      .      .
STD       .05649 .07195 .06299 .07218 .06601 .07299 .07210 .07547 .07527 .07069 .06593 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (RINDES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.56), S.S. RESIDUAL:.01013(SD:.00513))
MEAN      .00659 .20614 .19379 .20786 .20616 .19822 .20430 .20006 .20207 .19103 .20159 .      .      .      .      .
STD       .05644 .07190 .06295 .07206 .06678 .07281 .07210 .07527 .07495 .07065 .06577 ,      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .00775 .20745 .19543 .20917 .20732 .19966 .20583 .20109 .20243 .19193 .20252 .      .      .      .      .
STD       .05637 .07246 .06297 .07054 .06754 .07132 .07109 .07631 .07401 .06998 .06461 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.20))
MEAN      .00775 .20745 .19543 .20917 .20732 .19966 .20583 .20109 .20243 .19193 .20252 .      .      .      .      .
STD       .05637 .07246 .06297 .07054 .06754 .07132 .07109 .07631 .07401 .06990 .06461 .      .      .      .      .


                                        TABLE A3.170

                                ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10    # SET  2    R=0.00
                                         ---                   --          --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79398 .40342 .38949 .39117 .41171 .40680 .40583 .40556 .40566 .39033 .38023 .      .      .      .      .
STD       .07309 .10011 .05437 .08509 .08721 .09648 .09252 .08520 .08466 .09306 .07871 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (RINDES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.49), S.S. RESIDUAL:.04174(SD:.01019))
MEAN      .79194 .40226 .38799 .39010 .41059 .40570 .40456 .40408 .40453 .38057 .38739 .      .      .      .      .
STD       .07300 .09959 .09415 .08486 .08662 .09603 .09159 .08470 .08380 .09264 .07900 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.20))
MEAN      .79333 .40136 .38865 .39172 .40833 .40837 .40351 .40749 .40393 .39043 .38983 .      .      .      .      .
STD       .06990 .09500 .08922 .08176 .08592 .09345 .08720 .08121 .08176 .08560 .07843 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.36))
MEAN      .79333 .40136 .38865 .39172 .40833 .40837 .40351 .40749 .40393 .39043 .38983 .      .      .      .      .
STD       .06990 .09500 .08922 .08176 .04592 .09345 .08720 .08121 .08176 .08560 .07843 .      .      .      .      .
```

```
                                         TABLE A3.171

                                 ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10     B SET  3     R=0.00
                                        ---                   --          --      ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00440 .50794 .50046 .49509 .49630 .50694 .50127 .50372 .49620 .50371 .48160 .      .      .      .      .
STD       .06223 .08183 .10790 .08664 .09790 .09132 .10221 .09577 .09879 .09781 .08378 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.52), S.S. RESIDUAL:.04591(SD:.01190))
MEAN      .00086 .50577 .49947 .49112 .49963 .50444 .49962 .50251 .49477 .50118 .47895 .      .      .      .      .
STD       .06212 .08864 .10760 .08499 .09623 .08951 .10157 .09495 .09679 .09711 .08226 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.7(SD: 0.48))
MEAN      .00527 .50640 .49932 .49440 .49099 .50551 .50035 .50603 .50161 .50280 .48076 .      .      .      .      .
STD       .05881 .08844 .10481 .08510 .09086 .08550 .09596 .09479 .09376 .09510 .07836 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.41))
MEAN      .00527 .50640 .49932 .49440 .49099 .50551 .50035 .50603 .50161 .50280 .48076 .      .      .      .      .
STD       .05881 .08844 .10481 .08510 .09086 .08550 .09596 .09479 .09376 .09510 .07836 .      .      .      .      .


                                         TABLE A3.172

                                 ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 10     B SET  4     R=0.80
                                        ---                   --          --      ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ----------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85   .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79702 .10885 .15200 .19826 .24891 .31547 .39983 .50686 .69835 .80068 .84944 .      .      .      .      .
STD       .06271 .05437 .06181 .06725 .08509 .09481 .08859 .08445 .07657 .06569 .06548 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.7(SD: 0.51), S.S. RESIDUAL:.02215(SD:.00596))
MEAN      .79765 .10927 .15139 .19888 .24876 .31588 .39946 .50482 .68970 .80764 .84469 .      .      .      .      .
STD       .06116 .05462 .06138 .06575 .08411 .09372 .08760 .08679 .07695 .06591 .06598 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.30))
MEAN      .79053 .10888 .15121 .19925 .24251 .31783 .39879 .50536 .69138 .80895 .84816 .      .      .      .      .
STD       .06175 .05468 .05968 .06178 .08266 .09195 .08647 .08872 .07709 .06513 .06686 .      .      .      .      .
          ----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.44))
MEAN      .79052 .10888 .15121 .19925 .24251 .31782 .39879 .50536 .69138 .80894 .84816 .      .      .      .      .
STD       .06175 .05468 .05968 .06178 .08266 .09195 .08647 .08872 .07709 .06513 .06687 .      .      .      .      .
```

TABLE A3.173

```
                          ESTIMATION OF PARAMETERS FOR
         NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10    A SET  5    R=0.00
                             ---                    --           --    ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00103 .35050 .25793 .40702 .19635 .09900 .05067 .49693 .29195 .16211 .45022 .      .      .      .      .
STD       .05610 .00877 .07332 .08057 .07232 .06016 .03900 .08167 .09064 .07494 .09416 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.59), S.S. RESIDUAL:.02435(SD:.00697))
MEAN      .00039 .34999 .25735 .40596 .19616 .09630 .05020 .49591 .29307 .16166 .45770 .      .      .      .      .
STD       .05624 .00770 .07249 .07960 .07192 .06031 .03920 .08146 .08972 .07418 .09369 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.1(SD: 0.36))
MEAN      .00000 .35070 .25600 .40447 .19655 .09749 .05005 .49471 .29405 .16050 .45724 .      .      .      .      .
STD       .05596 .00541 .07146 .07956 .07161 .05836 .03802 .07904 .09020 .07001 .09270 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.40))
MEAN      .00000 .35070 .25600 .40447 .19655 .09740 .05005 .49471 .29404 .16050 .45724 .      .      .      .      .
STD       .05596 .00541 .07146 .07956 .07161 .05836 .03802 .07904 .09020 .07001 .09270 .      .      .      .      .
```

TABLE A3.174

```
                          ESTIMATION OF PARAMETERS FOR
         NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 10    B SET  6    R=0.00
                             ---                    --           --    ----

PARAMETER  R      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.05   0.55    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79153 .65696 .74934 .60412 .79910 .90451 .94034 .48747 .70040 .05537 .54492 .      .      .      .      .
STD       .08315 .09470 .09166 .09320 .07700 .06900 .04333 .10120 .08691 .07390 .09296 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.6(SD: 1.44), S.S. RESIDUAL:.02170(SD:.00640))
MEAN      .78302 .65119 .73950 .59921 .79512 .90330 .94500 .48290 .69070 .05157 .53050 .      .      .      .      .
STD       .08102 .09298 .08888 .09177 .07811 .06561 .04333 .09954 .08199 .07123 .08848 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP:  95, AVE # OF ITERATIONS: 9.5(SD: 2.50))
MEAN      .79437 .65701 .74340 .60156 .79940 .90333 .94722 .48948 .70346 .05337 .54747 .      .      .      .      .
STD       .06261 .08824 .08409 .08753 .07398 .06191 .04267 .09573 .07902 .07051 .08126 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  89, AVE # OF ITERATIONS: 7.1(SD: 3.25))
MEAN      .80060 .65792 .74891 .60072 .80453 .90101 .94234 .49741 .70705 .05221 .55500 .      .      .      .      .
STD       .07263 .09489 .08611 .09223 .07406 .06106 .04119 .10602 .07979 .07005 .08829 .      .      .      .      .
```

TABLE A3.175

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 A SET 7 R=0.00

PARAMETER	R	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}
VALUES	0.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
(SPEARMAN, # OF REP: 100)																
MEAN	.00095	.20017	.21114	.20446	.20939	.19780	.19170	.20413	.21037	.19400	.19659	.20252	.21170	.19700	.19196	.20155
STD	.06109	.06935	.07001	.06553	.07767	.06365	.07275	.07727	.07619	.06829	.07297	.06505	.07331	.06707	.06197	.07062
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.7(SD: 0.98), S.S. RESIDUAL:.04937(SD:.00077))																
MEAN	.00075	.20794	.21100	.20434	.20905	.19767	.19153	.20403	.21025	.19467	.19643	.20230	.21169	.19762	.19101	.20150
STD	.06116	.06928	.06987	.06526	.07759	.06361	.07250	.07720	.07608	.06807	.07206	.06569	.07754	.06697	.06193	.07050
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))																
MEAN	.00100	.20726	.21104	.20408	.20839	.19909	.19154	.20418	.20957	.19472	.19503	.20285	.21175	.19710	.19260	.20250
STD	.06133	.06907	.06914	.06413	.07746	.06343	.07181	.07634	.07305	.06750	.07167	.06450	.07750	.06679	.06218	.07135
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.19))																
MEAN	.00100	.20726	.21104	.20408	.20839	.19909	.19154	.20418	.20957	.19472	.19503	.20285	.21175	.19710	.19260	.20250
STD	.06133	.06907	.06914	.06413	.07746	.06343	.07181	.07634	.07305	.06750	.07167	.06450	.07750	.06679	.06218	.07135

TABLE A3.176

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 40 NUMBER OF ITEMS 15 A SET 8 R=0.80

PARAMETER	R	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}
VALUES	0.80	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
(SPEARMAN, # OF REP: 100)																
MEAN	.79130	.41059	.38383	.39393	.40565	.39571	.40400	.38500	.41250	.40699	.40194	.40139	.41064	.40792	.39900	.40390
STD	.06520	.08723	.08226	.07591	.09126	.08776	.09976	.09017	.09414	.09138	.08492	.08513	.08174	.08991	.09120	.08210
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.59), S.S. RESIDUAL:.10383(SD:.01987))																
MEAN	.78996	.40941	.38252	.39284	.40478	.39475	.40338	.38533	.41109	.40660	.40078	.40065	.40952	.40711	.39077	.40234
STD	.06518	.08609	.08234	.07555	.09118	.08715	.09959	.08998	.09391	.09163	.08527	.08473	.08124	.08967	.09094	.08299
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.20))																
MEAN	.78950	.40637	.38416	.38914	.40447	.39413	.39989	.38671	.40852	.40621	.40075	.39906	.40602	.41122	.39943	.40191
STD	.06505	.08489	.08195	.07414	.09291	.08432	.09889	.08842	.09191	.08820	.08636	.08426	.08036	.08459	.08760	.07910
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.39))																
MEAN	.78950	.40637	.38416	.38914	.40447	.39413	.39989	.38671	.40852	.40621	.40075	.39906	.40602	.41122	.39943	.40191
STD	.06505	.08489	.08195	.07414	.09291	.08432	.09889	.08842	.09191	.08820	.08636	.08426	.08036	.08459	.08760	.07910

TABLE A3.177

```
                         ESTIMATION OF PARAMETERS FOR
        NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15     I SET  9     A=0.00
                            ---                   --            --      ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
-------------------------------------------------------------------------------------------------------------------------
VALUES   0.00   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
-------------------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .70956 .50224 .50521 .48136 .49901 .50261 .50083 .49776 .52215 .51519 .49678 .50406 .49537 .50407 .49420 .50175
STD      .06165 .08304 .09091 .08900 .09553 .08578 .08815 .08927 .08859 .08604 .08838 .08116 .10335 .08437 .08966 .09415
-------------------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.50), S.S. RESIDUAL:.10985(SD:.01656))
MEAN     .70753 .50097 .50430 .48265 .49712 .50132 .50750 .49650 .52102 .51403 .49574 .50227 .49475 .50299 .49320 .49957
STD      .06160 .08100 .09040 .08843 .09544 .08542 .08772 .08876 .08731 .08694 .08740 .08181 .10302 .08376 .08957 .09120
-------------------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.33))
MEAN     .70903 .50393 .50564 .48519 .49360 .50303 .50037 .49739 .51990 .51601 .49550 .49912 .49870 .50400 .49472 .49759
STD      .05907 .07904 .08690 .08628 .09238 .08378 .08571 .09008 .08612 .08526 .08453 .08194 .10009 .08261 .08976 .09149
-------------------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.39))
MEAN     .70903 .50393 .50564 .48519 .49360 .50303 .50037 .49739 .51990 .51601 .49550 .49912 .49870 .50400 .49472 .49759
STD      .05907 .07904 .08690 .08628 .09238 .08378 .08571 .09008 .08612 .08526 .08453 .08194 .10009 .08261 .08976 .09149
```

TABLE A3.178

```
                         ESTIMATION OF PARAMETERS FOR
        NUMBER OF SUBJECTS  40    NUMBER OF ITEMS 15     I SET 10     A=0.00
                            ---                   --            --      ----

PARAMETER  A       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
-------------------------------------------------------------------------------------------------------------------------
VALUES   0.00   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
-------------------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .00757 .09061 .15190 .19262 .24255 .28604 .35555 .39221 .46630 .50913 .56099 .58779 .64036 .69951 .79202 .84382
STD      .05606 .05516 .06074 .06417 .07762 .07514 .07905 .08666 .08416 .10737 .08006 .09299 .08444 .08406 .07495 .06050
-------------------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.4(SD: 0.65), S.S. RESIDUAL:.06964(SD:.01251))
MEAN     .00575 .09010 .15170 .19136 .24245 .28609 .35474 .39063 .46596 .50714 .55000 .58712 .64694 .69010 .79127 .84296
STD      .05691 .05470 .06011 .06310 .07696 .07326 .08042 .08505 .08261 .10730 .07069 .09249 .08404 .08175 .07526 .06011
-------------------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.17))
MEAN     .00625 .09069 .15370 .19163 .24271 .28005 .35479 .39005 .46596 .50627 .55761 .58776 .64395 .69647 .79209 .84227
STD      .05734 .05109 .06764 .06461 .07590 .07019 .08175 .08466 .08040 .10455 .07504 .09162 .08674 .08209 .07391 .06010
-------------------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.43))
MEAN     .00625 .09069 .15370 .19167 .24271 .28005 .35479 .39005 .46596 .50627 .55761 .58776 .64395 .69647 .79209 .84227
STD      .05734 .05109 .06764 .06461 .07590 .07019 .08175 .08466 .08040 .10455 .07504 ,09162 .08674 .08209 .07391 .06010
```

```
                                    TABLE A3.179

                            ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 15     # SET 11     R=0.00
                                  ---                    --           --     ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ------------------------------------------------------------------------------------------------------------
VALUES     0.00   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
           ------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .00529 .10126 .14789 .19800 .25026 .30256 .35240 .40131 .45307 .49962 .04708 .14694 .24109 .33005 .46164 .24120
STD        .06411 .05275 .05953 .07062 .06708 .07670 .08312 .10040 .08599 .08193 .03015 .06019 .06713 .08540 .07507 .07641
           ------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.57), S.S. RESIDUAL:.06072(SD:.01107))
MEAN       .00490 .10097 .14739 .19452 .25032 .30245 .35207 .40123 .45241 .49430 .04703 .14692 .24153 .33730 .46135 .24114
STD        .06395 .05240 .05950 .06994 .06764 .07640 .08314 .10052 .08556 .08175 .03706 .05997 .06667 .08490 .07426 .07703
           ------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN       .00525 .10125 .14631 .18941 .25945 .30371 .35131 .40340 .45272 .49309 .04732 .14810 .24230 .33724 .46007 .24101
STD        .06309 .05210 .05906 .06709 .06751 .07509 .08236 .10001 .08391 .08109 .03021 .05800 .06509 .08320 .07350 .07750
           ------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.35))
MEAN       .00525 .10125 .14631 .18941 .25945 .30371 .35131 .40340 .45272 .49309 .04732 .14810 .24230 .33724 .46007 .24101
STD        .06309 .05210 .05906 .06709 .06751 .07509 .08236 .10001 .08391 .08109 .03021 .05800 .06509 .08320 .07350 .07750


                                    TABLE A3.180

                            ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS  40     NUMBER OF ITEMS 15     # SET 12     R=0.00
                                  ---                    --           --     ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
           ------------------------------------------------------------------------------------------------------------
VALUES     0.80   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
           ------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .80096 .90103 .84515 .79694 .76462 .70571 .66254 .60050 .56060 .50677 .95575 .84606 .75072 .66469 .53471 .75141
STD        .06012 .05604 .06730 .07709 .09064 .08491 .09005 .09343 .09779 .10050 .01851 .07151 .08506 .09012 .09629 .08310
           ------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.6(SD: 0.61), S.S. RESIDUAL:.06060(SD:.01093))
MEAN       .79417 .89930 .84362 .79622 .76037 .70132 .65809 .59605 .55510 .50264 .95371 .84330 .75654 .66001 .53330 .74910
STD        .07195 .05560 .06610 .07564 .09069 .08497 .08916 .08944 .09157 .09067 .01877 .06941 .08305 .08853 .09672 .08290
           ------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.90))
MEAN       .79426 .89922 .84651 .79732 .76119 .69981 .65716 .59299 .55536 .50356 .95417 .84070 .75660 .66066 .53602 .74893
STD        .05963 .05162 .06151 .07614 .08826 .08280 .08575 .08723 .09098 .08735 .01827 .06600 .07985 .08292 .09509 .08101
           ------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP:  99, AVE # OF ITERATIONS: 6.0(SD: 1.01))
MEAN       .79504 .89837 .84609 .79791 .76122 .69889 .65770 .59249 .55405 .50379 .95372 .84146 .75611 .66156 .53712 .74880
STD        .05905 .05285 .06141 .07649 .08864 .08283 .08620 .08601 .09068 .08770 .01817 .06705 .07955 .08295 .09540 .08131
```

```
                                        TABLE A3.101

                                   ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  1    K=0.30
                                      ---                    --          --    ----

PARAMETER  K      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           -----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30003 .19604 .19728 .19244 .19679 .20140 .19500 .20016 .19927 .19819 .19690 .      .      .      .      .
STD       .04419 .06643 .06504 .06437 .07158 .06742 .06641 .06573 .06875 .07011 .06560 .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.5(SD: 0.59), S.S. RESIDUAL:.00221(SD:.00076))
MEAN      .29996 .19585 .19708 .19227 .19659 .20121 .19482 .20012 .19902 .19823 .19679 .      .      .      .      .
STD       .04411 .06615 .06496 .06490 .07134 .06726 .06632 .06567 .06849 .07001 .06548 .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .30000 .19526 .19725 .19176 .19710 .20013 .19503 .20051 .19891 .19944 .19664 .      .      .      .      .
STD       .04422 .06180 .06650 .06657 .07152 .06716 .06601 .06500 .06690 .06973 .06483 .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.29))
MEAN      .30000 .19526 .19725 .19176 .19710 .20013 .19503 .20051 .19891 .19944 .19664 .      .      .      .      .
STD       .04422 .06180 .06650 .06657 .07152 .06716 .06601 .06500 .06690 .06973 .06483 .      .      .      .      .


                                        TABLE A3.102

                                   ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  2    K=0.30
                                      ---                    --          --    ----

PARAMETER  K      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
           -----------------------------------------------------------------------------------------------------------
VALUES    0.30   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30299 .39617 .41265 .40766 .40102 .40512 .40219 .39560 .39625 .40153 .40450 .      .      .      .      .
STD       .03996 .09396 .09397 .09471 .08507 .07975 .07803 .08750 .08270 .07110 .08392 .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.64), S.S. RESIDUAL:.00539(SD:.00149))
MEAN      .30213 .39514 .41130 .40624 .40169 .40337 .40152 .39435 .39457 .39977 .40324 .      .      .      .      .
STD       .01988 .09293 .09147 .09145 .08498 .07801 .07782 .08610 .08202 .07200 .08354 .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.27))
MEAN      .30262 .39440 .41069 .40737 .40216 .39791 .40477 .39571 .39692 .39954 .40553 .      .      .      .      .
STD       .04043 .08700 .08860 .08637 .08118 .07642 .07537 .08362 .08021 .07041 .07955 .      .      .      .      .
           -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.42))
MEAN      .30262 .39440 .41069 .40723 .40216 .39791 .40477 .39571 .39692 .39954 .40553 .      .      .      .      .
STD       .04043 .08700 .08860 .08637 .08118 .07642 .07537 .08162 .08021 .07041 .07955 .      .      .      .      .
```

```
                                    TABLE A3.103

                           ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    I SET  3    A=0.30
                                  ---                    --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
         ----------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .30475 .50043 .49706 .51121 .50302 .51002 .51132 .49627 .48655 .50404 .50037 .      .      .      .      .
STD      .04117 .08915 .09493 .07984 .07633 .08958 .09200 .09824 .08373 .08016 .07716 .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.54), S.S. RESIDUAL:.00560(SD:.00150))
MEAN     .30363 .49808 .49502 .50967 .50241 .50904 .50932 .49404 .48395 .50190 .49895 .      .      .      .      .
STD      .04096 .08817 .09789 .07962 .07771 .08971 .09134 .09830 .08218 .07653 .07686 .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.5(SD: 0.52))
MEAN     .30413 .50012 .49659 .50772 .50370 .51074 .51107 .49510 .48536 .50027 .49901 .      .      .      .      .
STD      .04014 .08207 .09370 .08054 .07530 .08713 .09057 .09502 .07622 .07874 .07686 .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.6(SD: 0.49))
MEAN     .30413 .50012 .49659 .50772 .50370 .51074 .51107 .49510 .48536 .50027 .49901 .      .      .      .      .
STD      .04014 .08207 .09370 .08054 .07530 .08713 .09057 .09502 .07622 .07874 .07686 .      .      .      .      .


                                    TABLE A3.104

                           ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    I SET  4    A=0.30
                                  ---                    --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
         ----------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .30277 .09345 .15207 .19907 .25395 .31376 .41039 .50129 .70710 .80051 .85400 .      .      .      .      .
STD      .04265 .05119 .05096 .06631 .07420 .08381 .08122 .08410 .08251 .06504 .06677 .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.56), S.S. RESIDUAL:.00280(SD:.00089))
MEAN     .30276 .09393 .15194 .19917 .25320 .31216 .41015 .50196 .70748 .79981 .85293 .      .      .      .      .
STD      .04251 .05103 .05926 .06569 .07222 .08210 .07935 .08362 .08103 .06409 .06685 .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.42))
MEAN     .30317 .09515 .15317 .19075 .25514 .30999 .41050 .50419 .70902 .80079 .85396 .      .      .      .      .
STD      .04260 .04960 .05039 .06615 .07109 .08141 .07866 .08172 .07971 .06312 .06485 .      .      .      .      .
         ----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.36))
MEAN     .30317 .09515 .15317 .19075 .25513 .30999 .41050 .50410 .70902 .80079 .85396 .      .      .      .      .
STD      .04260 .04960 .05039 .06615 .07109 .08141 .07866 .08171 .07971 .06312 .06485 .      .      .      .      .
```

```
                                        TABLE A3.105

                                ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  5    A=0.30
                                         ---                    --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30590 .35991 .25662 .30472 .19408 .10420 .05027 .49600 .29630 .16096 .44132 .      .      .      .      .
STD       .04394 .07175 .06983 .08151 .06744 .05095 .03072 .08625 .07270 .06081 .07034 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.59), S.S. RESIDUAL:.00294(SD:.00090))
MEAN      .30500 .35985 .25637 .30395 .19357 .10444 .05051 .49550 .29500 .16053 .44140 .      .      .      .      .
STD       .04391 .07125 .07007 .08087 .06752 .05097 .03080 .08613 .07231 .06035 .07013 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.2(SD: 0.37))
MEAN      .30503 .35907 .25594 .30302 .19396 .10476 .05099 .49403 .29650 .15016 .44275 .      .      .      .      .
STD       .04423 .07096 .06965 .08019 .06011 .05035 .03795 .08597 .07141 .05060 .07042 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.95))
MEAN      .30503 .35907 .25594 .30302 .19396 .10475 .05099 .49403 .29658 .15016 .44275 .      .      .      .      .
STD       .04423 .07096 .06965 .08019 .06011 .05035 .03795 .08597 .07142 .05060 .07042 .      .      .      .      .


                                        TABLE A3.106

                                ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  6    A=0.30
                                         ---                    --          --    ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29631 .64174 .76269 .60419 .79894 .91107 .95254 .50102 .70040 ,84858 .55305 .      .      .      .      .
STD       .04157 .08985 .07136 .08530 .07491 .05091 .03610 .09491 .08503 .06878 :08302 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.4(SD: 1.30), S.S. RESIDUAL:.00285(SD:.00083))
MEAN      .29137 .63670 .75960 .60047 .79217 .90629 .95090 .49513 .69699 .84509 .54323 .      .      .      .      .
STD       .04214 .08903 .06704 .08703 .07312 .04983 .03525 .09451 .08597 .06406 .08253 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 7.2(SD: 1.24))
MEAN      .29540 .64259 .76307 .60977 .79360 .90352 .95144 .50170 .70222 .84552 .54870 .      .      .      .      .
STD       .03047 .08246 .06223 .08089 .04863 .05017 .03521 .09199 .08157 .05914 .07421 .      .      .      .      .
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP:  97, AVE # OF ITERATIONS: 7.1(SD: 2.76))
MEAN      .29862 .64391 .76611 .61115 .79356 .90247 .95039 .50565 .70545 .84552 .55526 .      .      .      .      .
STD       .03908 .08109 .06251 .08156 .06705 .04880 .01406 .09422 .08106 .05707 .07524 .      .      .      .      .
```

```
                                   TABLE A3.107

                           ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET  7    R=0.30
                                   ---                    --          --      ----

PARAMETER  R       R      R      R      R      R      R      R      R      R      R      R      R      R      R      R
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         -----------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20
         -----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .31004 .20424 .19417 .19591 .20195 .20372 .19022 .19905 .19741 .20032 .18552 .20263 .21647 .20556 .20471 .21011
STD      .04209 .06984 .06555 .06422 .06330 .07030 .06500 .06151 .06149 .06632 .06165 .06454 .07292 .06715 .06518 .06580
         -----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.3(SD: 0.64), S.S. RESIDUAL:.00507(SD:.00131))
MEAN     .31080 .20482 .19403 .19579 .20101 .20361 .19014 .19961 .19735 .20026 .18546 .20244 .21644 .20547 .20459 .21009
STD      .04210 .06884 .06559 .06435 .06133 .07033 .06499 .06137 .06154 .06622 .06170 .06445 .07209 .06740 .06514 .06574
         -----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN     .31067 .20314 .19355 .19611 .20175 .20351 .18961 .19907 .19703 .20754 .18658 .20143 .21619 .20550 .20414 .20837
STD      .04208 .06847 .06601 .06430 .06361 .06930 .06560 .06004 .06293 .06390 .06280 .06426 .07276 .06562 .06440 .06615
         -----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.19))
MEAN     .31067 .20314 .19355 .19611 .20175 .20351 .18961 .19907 .19703 .20754 .18658 .20143 .21619 .20550 .20414 .20837
STD      .04208 .06847 .06601 .06430 .06361 .06930 .06560 .06004 .06293 .06390 .06280 .06426 .07276 .06562 .06440 .06615


                                   TABLE A3.108

                           ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET  8    R=0.30
                                   ---                    --          --      ----

PARAMETER  R       R      R      R      R      R      R      R      R      R      R      R      R      R      R      R
                    1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         -----------------------------------------------------------------------------------------------------------------
VALUES   0.30   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40
         -----------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .30023 .40390 .39763 .40044 .39609 .42035 .40363 .40308 .40945 .39731 .40663 .41442 .41362 .36917 .40767 .38946
STD      .04106 .08924 .08017 .08720 .08232 .07510 .07944 .08706 .09108 .08035 .08365 .08911 .09079 .07942 .08206 .08222
         -----------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.1(SD: 0.51), S.S. RESIDUAL:.01313(SD:.00276))
MEAN     .29984 .40354 .39726 .39959 .39501 .41929 .40303 .40350 .40858 .39719 .40606 .41360 .41203 .36903 .40646 .38860
STD      .04180 .08885 .07972 .08683 .08190 .07498 .07873 .08759 .09175 .08018 .08294 .08886 .09078 .07908 .08218 .08230
         -----------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.17))
MEAN     .30008 .40376 .39905 .39900 .39576 .41935 .40479 .40400 .40802 .39757 .40357 .41103 .41051 .37208 .40666 .38307
STD      .04166 .08608 .07995 .08668 .08045 .07330 .07814 .08820 .08811 .08628 .07969 .08827 .09693 .08851 .08843 .08119
         -----------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.43))
MEAN     .30008 .40376 .39905 .39900 .39576 .41935 .40479 .40400 .40802 .39757 .40357 .41103 .41051 .37208 .40666 .38307
STD      .04166 .08608 .07995 .08668 .08045 .07330 .07814 .08820 .08811 .08628 .07969 .08827 .09693 .08851 .08843 .08119
```

```
                                         TABLE A3.189

                                 ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS 120     NUMBER OF ITEMS 15     A SET  9     R=0.30
                                      ---                     --            --      ----

PARAMETER  R      A       A       A       A       A       A       A       A       A       A       A       A       A       A       A
                   1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30420 .50465 .48808 .49642 .50077 .50756 .50029 .48379 .50241 .51196 .50167 .51792 .48781 .49224 .49063 .49730
STD       .04171 .09046 .08522 .08150 .08560 .08566 .08219 .08764 .08758 .08425 .08747 .09425 .08502 .09431 .08407 .08267
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.61), S.S. RESIDUAL:.01990(SD:.00301))
MEAN      .30330 .50365 .48693 .49512 .50716 .50613 .49938 .48346 .50879 .51060 .50061 .51675 .48638 .49104 .48897 .49604
STD       .04153 .08917 .08508 .08046 .08553 .08503 .08238 .08694 .08683 .08404 .08754 .09410 .08407 .09274 .08415 .08223
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.39))
MEAN      .30468 .50794 .49066 .49802 .50810 .50867 .50063 .48737 .50067 .51297 .50170 .51698 .48613 .49398 .48969 .49738
STD       .04123 .08179 .08179 .07632 .08450 .08540 .08221 .08675 .08382 .08423 .08550 .09017 .07945 .08919 .08263 .07948
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.5(SD: 0.50))
MEAN      .30468 .50794 .49066 .49802 .50810 .50867 .50063 .48737 .50067 .51297 .50170 .51698 .48613 .49398 .48969 .49738
STD       .04123 .08179 .08179 .07632 .08450 .08540 .08221 .08675 .08382 .08423 .08550 .09017 .07945 .08919 .08263 .07948


                                         TABLE A3.190

                                 ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS 120     NUMBER OF ITEMS 15     A SET 10     R=0.30
                                      ---                     --            --      ----

PARAMETER  R      A       A       A       A       A       A       A       A       A       A       A       A       A       A       A
                   1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.80    0.80    0.85
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .30084 .09085 .15550 .20176 .25921 .30527 .35504 .39335 .44930 .50119 .55357 .59900 .64174 .70669 .75915 .84790
STD       .03013 .04571 .06291 .06515 .07959 .07730 .07973 .08675 .09024 .09591 .09065 .07682 .09411 .06970 .06761 .06302
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.0(SD: 0.63), S.S. RESIDUAL:.00069(SD:.00107))
MEAN      .30070 .09514 .15470 .20066 .25493 .30373 .35571 .39368 .44921 .50039 .55206 .59803 .64167 .70760 .75070 .84701
STD       .03790 .04549 .06200 .06424 .07067 .07710 .07841 .08410 .09015 .09460 .08967 .07553 .09331 .06932 .06710 .06269
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.20))
MEAN      .30100 .09977 .15620 .19820 .25910 .30495 .35601 .39356 .44933 .50007 .55427 .59751 .64404 .70099 .75966 .84060
STD       .03765 .04400 .06174 .06271 .07751 .07590 .07841 .08322 .09094 .09157 .08931 .07451 .09130 .06665 .06591 .06092
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.29))
MEAN      .30100 .09977 .15620 .19820 .25910 .30495 .35601 .39356 .44933 .50007 .55427 .59751 .64404 .70099 .75966 .84060
STD       .03765 .04400 .06174 .06271 .07751 .07590 .07841 .08322 .09094 .09157 .08931 .07451 .09130 .06665 .06591 .06092
```

```
                                        TABLE A3.191

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15     B SET 11     A=0.30
                                    ---                    --           --       ----

PARAMETER  A     B1     B2     B3     B4     B5     B6     B7     B8     B9     B10    B11    B12    B13    B14    B15
          ---------------------------------------------------------------------------------------------------------
VALUES    0.30   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          ---------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29420 .10200 .15205 .20005 .25244 .30651 .35237 .40000 .44045 .50502 .04919 .15046 .24031 .34760 .45352 .25100
STD       .04456 .05000 .05960 .07164 .07557 .08564 .07964 .06969 .07905 .09613 .03616 .05396 .08331 .08546 .08784 .08212
          ---------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.41), S.S. RESIDUAL:.00755(SD:.00170))
MEAN      .29410 .10262 .15270 .20057 .25179 .30622 .35249 .40753 .44023 .50551 .04899 .15067 .24007 .34713 .45307 .25196
STD       .04460 .05003 .05968 .07109 .07506 .08542 .07959 .06959 .07966 .09605 .03500 .05361 .08329 .08809 .08731 .08198
          ---------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .29442 .10273 .15309 .20070 .25429 .30703 .35211 .40062 .44026 .50543 .04895 .15203 .24130 .34026 .45467 .25163
STD       .04456 .04700 .05030 .07072 .07534 .08410 .08025 .06970 .08007 .09619 .03547 .05351 .08261 .08174 .08524 .07940
          ---------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.26))
MEAN      .29442 .10273 .15309 .20070 .25429 .30703 .35211 .40062 .44026 .50543 .04895 .15203 .24130 .34026 .45467 .2[illegible]3
STD       .04456 .04700 .05030 .07072 .07534 .08410 .08025 .06970 .08007 .09619 .03547 .05351 .08261 .08174 .08524 .07940
```

```
                                        TABLE A3.192

                                ESTIMATION OF PARAMETERS FOR
                 NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15     B SET 12     A=0.30
                                    ---                    --           --       ----

PARAMETER  A     B1     B2     B3     B4     B5     B6     B7     B8     B9     B10    B11    B12    B13    B14    B15
          ---------------------------------------------------------------------------------------------------------
VALUES    0.30   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.85   0.75   0.65   0.55   0.75
          ---------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .29649 .89502 .84371 .79729 .74973 .68985 .63057 .59940 .56063 .50013 .95430 .84420 .76373 .65036 .50960 .74805
STD       .04398 .05719 .05904 .07398 .07213 .08338 .09539 .09269 .09730 .09331 .04166 .06442 .07367 .07295 .08362 .07995
          ---------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.58), S.S. RESIDUAL:.00769(SD:.00177))
MEAN      .29365 .89444 .84192 .79470 .74743 .68781 .62022 .59519 .55549 .49433 .95291 .84210 .76067 .65009 .54553 .74709
STD       .04371 .05497 .05826 .07333 .07058 .08342 .09005 .09846 .09513 .09204 .04216 .06367 .06935 .07124 .08659 .07079
          ---------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.5(SD: 0.50))
MEAN      .29000 .89781 .84242 .79458 .75132 .69211 .63066 .60243 .56191 .49933 .95362 .84504 .76230 .65620 .55262 .75208
STD       .04348 .05101 .05537 .07156 .06992 .07534 .08551 .08100 .08610 .08590 .04084 .06201 .06722 .06602 .08215 .07509
          ---------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 0.68))
MEAN      .29044 .89798 .84266 .79491 .75169 .69255 .63120 .60290 .56250 .50012 .95364 .84523 .76250 .65617 .55310 .75207
STD       .04132 .05094 .05570 .07111 .06982 .07587 .08547 .08152 .08630 .08573 .04084 .06191 .06714 .06577 .08201 .07571
```

```
                              TABLE A3.193

                     ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  1    A=0.50
                             ---                    --          --      ----

PARAMETER  A      B      B      B      B      B      B      B   .  B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------
VALUES    0.50   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49950 .19922 .19889 .20359 .20241 .19535 .20203 .20658 .20009 .19938 .20065 .      .      .      .      .
STD       .04550 .05174 .04937 .05052 .05535 .04734 .04903 .04917 .05390 .04999 .05024 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.5(SD: 0.50), S.S. RESIDUAL:.00387(SD:.00103))
MEAN      .49930 .19913 .19865 .20153 .20235 .19511 .20189 .20645 .20062 .19923 .20050 .      .      .      .      .
STD       .04561 .05166 .04983 .05036 .05527 .04718 .04889 .04909 .05388 .04990 .05019 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .49942 .19977 .19822 .20481 .20170 .19541 .20225 .20661 .19988 .19927 .19956 .      .      .      .      .
STD       .04560 .05026 .04879 .04883 .05470 .04536 .04854 .04860 .05354 .04718 .04855 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.39))
MEAN      .49942 .19977 .19822 .20481 .20170 .19541 .20225 .20661 .19988 .19927 .19956 .      .      .      .      .
STD       .04560 .05026 .04879 .04883 .05470 .04536 .04854 .04860 .05354 .04718 .04855 .      .      .      .      .


                              TABLE A3.194

                     ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  2    A=0.50
                             ---                    --          --      ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------
VALUES    0.50   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50111 .39867 .40009 .40069 .40411 .39945 .39931 .39543 .40009 .40141 .39735 .      .      .      .      .
STD       .04929 .06834 .06236 .06952 .05881 .06203 .06981 .06204 .06558 .07886 .06455 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.54), S.S. RESIDUAL:.00894(SD:.00204))
MEAN      .50061 .39814 .39967 .40029 .40379 .39896 .39888 .39515 .39968 .40040 .39665 .      .      .      .      .
STD       .04937 .06764 .06216 .06887 .05855 .06175 .06958 .06183 .06537 .07806 .06448 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.29))
MEAN      .50055 .39888 .39908 .40933 .40365 .39623 .39934 .39615 .39993 .39821 .39681 .      .      .      .      .
STD       .04851 .06418 .06063 .06626 .05858 .05931 .07090 .06125 .06349 .07626 .06346 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.4(SD: 0.50))
MEAN      .50055 .39888 .39908 .40933 .40365 .39623 .39934 .39615 .39993 .39821 .39681 .      .      .      .      .
STD       .04851 .06418 .06063 .06626 .05858 .05931 .07090 .06125 .06349 .07626 .06346 .      .      .      .      .
```

TABLE A3.195

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 120 NUMBER OF ITEMS 10 B SET 1 R=0.50

PARAMETER	R	B_{1}	B_{2}	B_{3}	B_{4}	B_{5}	B_{6}	B_{7}	B_{8}	B_{9}	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	.	.	.	.	.
(SPEARMAN, # OF REP: 100)																
MEAN	.49943	.50569	.48272	.49302	.49731	.49163	.50089	.49712	.51341	.49478	.50268	.	.	.	.	.
STD	.04449	.06201	.07129	.06480	.06204	.06411	.06056	.06790	.06185	.06473	.06315	.	.	.	.	.
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.54), S.S. RESIDUAL:.00967(SD:.00230))																
MEAN	.49843	.50510	.48217	.49188	.49640	.49053	.50016	.49505	.51279	.49366	.50119	.	.	.	.	.
STD	.04460	.06131	.07049	.06391	.06229	.06394	.05995	.06740	.06146	.06407	.06157	.	.	.	.	.
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.4(SD: 0.49))																
MEAN	.50032	.50082	.48506	.49417	.49840	.49211	.50245	.49656	.51465	.49571	.49999	.	.	.	.	.
STD	.04233	.05982	.06640	.05961	.05902	.06442	.05759	.06751	.06169	.06109	.05875	.	.	.	.	.
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.40))																
MEAN	.50032	.50082	.48506	.49417	.49840	.49211	.50245	.49656	.51465	.49571	.49999	.	.	.	.	.
STD	.04233	.05982	.06640	.05961	.05902	.06442	.05759	.06751	.06169	.06109	.05875	.	.	.	.	.

TABLE A3.196

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 120 NUMBER OF ITEMS 10 B SET 4 R=0.50

PARAMETER	R	B_{1}	B_{2}	B_{3}	B_{4}	B_{5}	B_{6}	B_{7}	B_{8}	B_{9}	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.50	0.10	0.15	0.20	0.25	0.30	0.40	0.50	0.70	0.80	0.85	.	.	.	.	.
(SPEARMAN, # OF REP: 100)																
MEAN	.50019	.10021	.15227	.19309	.24262	.29910	.39806	.50035	.70150	.81095	.85041	.	.	.	.	.
STD	.04471	.03729	.04747	.05428	.05473	.06409	.06567	.06446	.05577	.04917	.04584	.	.	.	.	.
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.56), S.S. RESIDUAL:.00963(SD:.00116))																
MEAN	.49979	.09976	.15158	.19294	.24234	.29807	.39796	.49960	.70044	.81060	.84947	.	.	.	.	.
STD	.04489	.03640	.04731	.05310	.05522	.06376	.06373	.06339	.05534	.04920	.04466	.	.	.	.	.
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))																
MEAN	.50043	.10059	.15213	.19420	.24367	.29949	.39932	.49884	.69955	.81007	.84969	.	.	.	.	.
STD	.04494	.03634	.04616	.05459	.05471	.06566	.06297	.06143	.05554	.04925	.04455	.	.	.	.	.
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.17))																
MEAN	.50043	.10059	.15213	.19420	.24367	.29949	.39932	.49884	.69955	.81007	.84969	.	.	.	.	.
STD	.04494	.03634	.04616	.05459	.05471	.06566	.06297	.06143	.05554	.04925	.04455	.	.	.	.	.

```
                                         TABLE A3.197

                                ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  5    K=0.50
                                        ---                    --          --      ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.35    0.25    0.40    0.20    0.10    0.05    0.50    0.30    0.15    0.45     .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49606 .35395 .24891 .39582 .20953 .10520 .05061 .50731 .29094 .14750 .45975 .       .       .       .       .
STD       .04861 .05021 .05570 .06315 .06073 .03944 .02937 .06426 .06778 .04783 .06025 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.4(SD: 0.54), S.S. RESIDUAL:.00495(SD:.00122))
MEAN      .49593 .35401 .24884 .39618 .20006 .10504 .05031 .50723 .29105 .14726 .45919 .       .       .       .       .
STD       .04852 .05395 .05504 .06269 .06039 .03920 .02919 .06371 .06726 .04647 .06751 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.20))
MEAN      .49617 .35398 .24884 .39679 .20835 .10519 .05090 .50781 .29288 .14704 .45929 .       .       .       .       .
STD       .04851 .05030 .05389 .06098 .05786 .03895 .02829 .06370 .06687 .04527 .06620 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.40))
MEAN      .49617 .35398 .24884 .39678 .20835 .10519 .05090 .50781 .29288 .14704 .45929 .       .       .       .       .
STD       .04851 .05030 .05389 .06098 .05786 .03895 .02829 .06370 .06687 .04527 .06620 .       .       .       .       .


                                         TABLE A3.198

                                ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  6    K=0.50
                                        ---                    --          --      ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.65    0.75    0.60    0.80    0.90    0.95    0.50    0.70    0.85    0.55     .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50409 .65769 .75490 .60930 .80560 .90172 .94576 .49772 .69062 .85209 .55100 .       .       .       .       .
STD       .04100 .07215 .06220 .07216 .05115 .03319 .03108 .07008 .06555 .04936 .07005 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.4(SD: 1.01), S.S. RESIDUAL:.00486(SD:.00116))
MEAN      .50120 .65553 .75124 .60630 .80242 .89874 .94509 .49552 .68942 .85173 .54961 .       .       .       .       .
STD       .04416 .07047 .06026 .06915 .04957 .03472 .03104 .06715 .06243 .04716 .06752 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 7.2(SD: 1.11))
MEAN      .50042 .65400 .74996 .60308 .80179 .89712 .94601 .49546 .69140 .85270 .54904 .       .       .       .       .
STD       .03966 .06917 .05709 .06955 .04749 .03503 .03062 .06224 .06201 .04450 .06490 .       .       .       .       .
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 1.59))
MEAN      .50181 .65400 .75056 .60414 .80235 .89742 .94601 .49669 .69217 .85304 .55013 .       .       .       .       .
STD       .04080 .06962 .05715 .06491 .04707 .03491 .03062 .06267 .06191 .04467 .06547 .       .       .       .       .
```

TABLE A3.199

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 120   NUMBER OF ITEMS 15   B SET 7   A=0.50

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
(SPEARMAN, # OF REP: 100)																
MEAN	.50091	.20845	.20702	.20315	.20074	.20122	.19392	.20368	.20226	.20319	.19550	.19609	.20565	.20203	.20319	.19420
STD	.04084	.04912	.05248	.05192	.05011	.05677	.05293	.04975	.05143	.05017	.05185	.04808	.05849	.04982	.05650	.04773
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.2(SD: 0.64), S.S. RESIDUAL:.00992(SD:.00150))																
MEAN	.50089	.20845	.20685	.20309	.20060	.20110	.19382	.20360	.20210	.20114	.19581	.19600	.20550	.20270	.20019	.19416
STD	.04082	.04909	.05229	.05190	.05004	.05666	.05293	.04984	.05139	.05014	.05173	.04796	.05843	.04901	.05643	.04775
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))																
MEAN	.50092	.21069	.20642	.20290	.20122	.20096	.19413	.20275	.20273	.20059	.19516	.19609	.20615	.20293	.20050	.19393
STD	.04077	.04943	.05085	.05274	.04933	.05584	.05328	.05056	.05063	.05628	.05044	.04641	.05706	.04073	.05527	.04707
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.45))																
MEAN	.50092	[illegible]	.20642	.20290	.20122	.20096	.19413	.20275	.20273	.20059	.19516	.19609	.20615	.20293	.20050	.19393
STD	.04077	[illegible]	.05085	.05274	.04933	.05584	.05328	.05056	.05063	.05628	.05044	.04641	.05706	.04073	.05527	.04707

TABLE A3.200

ESTIMATION OF PARAMETERS FOR
NUMBER OF SUBJECTS 120   NUMBER OF ITEMS 15   B SET 8   A=0.50

PARAMETER	A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}
VALUES	0.50	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
(SPEARMAN, # OF REP: 100)																
MEAN	.49314	.40341	.41129	.40713	.39639	.40150	.40494	.41207	.40342	.40600	.39157	.39201	.40796	.39900	.40693	.40607
STD	.04156	.06076	.06951	.06467	.05936	.07210	.06525	.06013	.06981	.06099	.06677	.06043	.06437	.07506	.07092	.06342
(MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.52), S.S. RESIDUAL:.02197(SD:.00377))																
MEAN	.49270	.40200	.41088	.40672	.39569	.40117	.40431	.41246	.40315	.40566	.39124	.39152	.40740	.39943	.40672	.40551
STD	.04164	.06067	.06914	.06459	.05998	.07133	.06503	.06015	.06979	.06869	.06670	.05995	.06190	.07403	.07046	.06295
(GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))																
MEAN	.49317	.40486	.41004	.40725	.39443	.40080	.40496	.41192	.40458	.40503	.39176	.39273	.40695	.40164	.40504	.40536
STD	.04193	.05977	.06710	.06440	.05641	.06994	.06311	.06737	.06953	.06049	.06693	.05982	.06502	.07307	.06071	.06023
(NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.1(SD: 0.47))																
MEAN	.49317	.40486	.41004	.40725	.39443	.40080	.40496	.41192	.40458	.40503	.39176	.39273	.40695	.40164	.40504	.40536
STD	.04193	.05977	.06710	.06440	.05641	.06994	.06311	.06737	.06953	.06049	.06693	.05982	.06502	.07307	.06071	.06023

```
                                          TABLE A3.201

                                 ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET  9    R=0.50
                                         ---                   --          --     ----

PARAMETER  R       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ---------------------------------------------------------------------------------------------------------------------------
VALUES     0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
           ---------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .50196 .50270 .49233 .50188 .49850 .49877 .50734 .49270 .50038 .49816 .49964 .49999 .50095 .49207 .50150 .50306
STD        .04642 .06896 .06069 .07029 .07456 .06697 .06092 .06483 .05063 .06604 .06766 .06579 .07243 .06758 .06739 .06970
           ---------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.5(SD: 0.50), S.S. RESIDUAL:.02306(SD:.00369))
MEAN       .50109 .50190 .49203 .50131 .49763 .49790 .50616 .49236 .49939 .49727 .49866 .49900 .50047 .49130 .50090 .50229
STD        .04649 .06871 .06068 .06955 .07421 .06720 .06057 .06356 .06264 .06530 .06735 .06510 .07206 .06725 .06742 .06089
           ---------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.7(SD: 0.45))
MEAN       .50110 .50134 .49135 .50025 .49701 .49607 .50402 .49399 .49743 .49721 .49956 .49922 .50153 .49317 .50172 .50011
STD        .04648 .06454 .06105 .06753 .07144 .06639 .05918 .06291 .06983 .06254 .06542 .06193 .06986 .06509 .06590 .06854
           ---------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.38))
MEAN       .50110 .50134 .49135 .50025 .49701 .49607 .50402 .49399 .49743 .49721 .49956 .49922 .50153 .49317 .50172 .50011
STD        .04648 .06454 .06105 .06753 .07144 .06639 .05918 .06291 .06983 .06254 .06542 .06193 .06986 .06509 .06590 .06854


                                          TABLE A3.202

                                 ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET 10    R=0.50
                                         ---                   --          --     ----

PARAMETER  R       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ---------------------------------------------------------------------------------------------------------------------------
VALUES     0.50    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.70    0.80    0.85
           ---------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .50346 .10754 .15095 .20030 .25309 .29780 .33912 .40923 .45211 .51561 .54556 .61059 .65632 .69858 .79987 .85207
STD        .04091 .03603 .0469[illegible] .05395 .05272 .05604 .06457 .05910 .06076 .06716 .06499 .06771 .05666 .05558 .04997 .04714
           ---------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.50), S.S. RESIDUAL:.01477(SD:.00255))
MEAN       .50348 .10749 .15111 .19904 .25308 .29761 .33803 .40349 .45235 .51487 .54578 .61044 .65584 .69908 .79986 .85251
STD        .04078 .03645 .04644 .05321 .05235 .05591 .06487 .05814 .06032 .06752 .06432 .06702 .05640 .05583 .04949 .04709
           ---------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN       .50433 .10602 .15211 .20210 .25509 .29845 .33938 .40464 .45471 .51390 .54605 .61102 .65726 .69985 .80062 .85324
STD        .04092 .01563 .04761 .05270 .05158 .05440 .06308 .05756 .05973 .06778 .06195 .06373 .05678 .05550 .04813 .04687
           ---------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.29))
MEAN       .50433 .10602 .15211 .20210 .25509 .29845 .33938 .40464 .45471 .51390 .54605 .61102 .65726 .69985 .80062 .85324
STD        .04092 .01563 .04761 .05270 .05158 .05440 .06308 .05756 .05973 .06778 .06195 .06373 .05678 .05550 .04813 .04687
```

TABLE A3.203

```
                                ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET 11    A=0.50
                                ---                    --          --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.05    0.15    0.25    0.35    0.45    0.25
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .50398 .10616 .15000 .20419 .23929 .30360 .34815 .39913 .44402 .50169 .05195 .14303 .24819 .35476 .44896 .24532
STD       .04560 .04443 .04407 .05130 .05278 .06094 .05920 .06412 .06513 .06226 .02022 .04107 .05724 .06617 .06160 .05777
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.43)), S.S. RESIDUAL:.01209(SD:.00250))
MEAN      .50392 .10604 .15754 .20420 .23926 .30350 .34831 .39942 .44402 .50165 .05195 .14309 .24796 .35423 .44075 .24512
STD       .04549 .04402 .04405 .05111 .05292 .06100 .05091 .06408 .06403 .06232 .02024 .04096 .05706 .06606 .06168 .05737
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .50367 .10550 .15505 .20421 .23832 .30301 .34825 .40040 .44352 .50273 .05204 .14393 .24690 .35160 .44090 .24520
STD       .04523 .04401 .04334 .05336 .05317 .06137 .05003 .06390 .06524 .06222 .02018 .03990 .05650 .06512 .06073 .05721
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.35))
MEAN      .50367 .10550 .15505 .20421 .23832 .30301 .34825 .40040 .44352 .50273 .05204 .14393 .24690 .35160 .44090 .24520
STD       .04523 .04401 .04334 .05336 .05317 .06137 .05003 .06390 .06524 .06222 .02018 .03990 .05650 .06512 .06073 .05721
```

TABLE A3.204

```
                                ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET 12    A=0.50
                                ---                    --          --      ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.50    0.90    0.85    0.80    0.75    0.70    0.65    0.60    0.55    0.50    0.95    0.85    0.75    0.65    0.55    0.75
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .49680 .90019 .84890 .80030 .75374 .70795 .64651 .59715 .54501 .49940 .95321 .84172 .75686 .64899 .54680 .73993
STD       .04913 .04143 .04373 .05475 .06072 .06348 .06463 .06915 .07002 .07720 .02835 .04868 .06526 .06808 .06429 .05526
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.66)), S.S. RESIDUAL:.01200(SD:.00261))
MEAN      .49381 .90003 .84709 .79894 .75106 .70527 .64400 .59475 .54259 .49720 .95217 .84094 .75039 .64789 .54373 .73940
STD       .04907 .04002 .04267 .05560 .05656 .06122 .06385 .06841 .06875 .07692 .02709 .04673 .06415 .06565 .06205 .05402
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.5(SD: 0.59))
MEAN      .49732 .90043 .84815 .80244 .75494 .70616 .64503 .59619 .54511 .50213 .95302 .84127 .75466 .64963 .54738 .74000
STD       .04556 .03751 .04204 .05046 .05289 .06002 .06196 .06189 .06400 .07120 .02724 .04399 .06190 .06224 .05805 .05202
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.4(SD: 0.50))
MEAN      .49747 .90042 .84819 .80250 .75504 .70625 .64515 .59652 .54525 .50228 .95302 .84130 .75473 .64973 .54757 .74096
STD       .04558 .03751 .04202 .05097 .05283 .06001 .06109 .06105 .06496 .07719 .02724 .04401 .06109 .06224 .05879 .05198
```

TABLE A3.205

```
                         ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  1    A=0.70
                             ---                    --         --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         ------------------------------------------------------------------------------------------------------------
VALUES   0.70   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20     .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .70637 .19845 .20719 .19834 .19531 .19492 .20410 .20659 .20156 .20002 .19563 .      .      .      .      .
STD      .04629 .04972 .04630 .04391 .04640 .04500 .04503 .04479 .04320 .04105 .04520 .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.3(SD: 0.61), S.S. RESIDUAL:.00592(SD:.00165))
MEAN     .70627 .19835 .20712 .19810 .19523 .19492 .20412 .20646 .20158 .19992 .19551 .      .      .      .      .
STD      .04631 .04963 .04632 .04391 .04639 .04501 .04495 .04466 .04319 .04106 .04523 .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN     .70642 .19906 .20666 .19705 .19581 .19499 .20190 .20594 .20215 .20061 .19563 .      .      .      .      .
STD      .04631 .04849 .04529 .04377 .04607 .04516 .04403 .04402 .04276 .04104 .04401 .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.46))
MEAN     .70642 .19906 .20666 .19705 .19581 .19499 .20190 .20594 .20215 .20061 .19562 .      .      .      .      .
STD      .04631 .04849 .04529 .04377 .04607 .04516 .04403 .04402 .04276 .04104 .04401 .      .      .      .      .
```

TABLE A3.206

```
                         ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  2    A=0.70
                             ---                    --         --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
         ------------------------------------------------------------------------------------------------------------
VALUES   0.70   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40     .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (SPEARMAN, # OF REP: 100)
MEAN     .69540 .40394 .41005 .39050 .39477 .40545 .40809 .39510 .40570 .40363 .39706 .      .      .      .      .
STD      .04279 .06199 .05073 .05537 .05443 .05202 .05552 .05190 .04859 .05340 .05716 .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.59), S.S. RESIDUAL:.01273(SD:.00336))
MEAN     .69454 .40374 .40800 .39005 .39430 .40491 .40850 .39442 .40500 .40299 .39710 .      .      .      .      .
STD      .04277 .06164 .05027 .05401 .05392 .05150 .05516 .05130 .04845 .05267 .05674 .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.27))
MEAN     .69500 .40573 .40606 .39246 .39526 .40437 .41060 .39450 .40607 .40211 .39594 .      .      .      .      .
STD      .04146 .05073 .04760 .05172 .05100 .04934 .05225 .04950 .04746 .04997 .05510 .      .      .      .      .
         ------------------------------------------------------------------------------------------------------------
         (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.3(SD: 0.44))
MEAN     .69500 .40573 .40606 .39246 .39526 .40437 .41060 .39450 .40607 .40211 .39594 .      .      .      .      .
STD      .04146 .05073 .04760 .05172 .05100 .04934 .05225 .04950 .04746 .04997 .05510 .      .      .      .      .
```

```
                                          TABLE A3.207

                                  ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  3    K=0.70
                                         ---                      --         --     ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ------------------------------------------------------------------------------------------------------------------------
VALUES     0.70    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50     .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .70109 .50157 .49375 .50225 .50609 .49571 .49361 .50360 .50475 .49494 .49386 .       .       .       .       .
STD        .03032 .05526 .05427 .05320 .05011 .05449 .05074 .05005 .05014 .05953 .05380 .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.60), S.S. RESIDUAL:.01376(SD:.00274))
MEAN       .70203 .50075 .49205 .50130 .50628 .49516 .49270 .50247 .50456 .49490 .49295 .       .       .       .       .
STD        .03042 .05505 .05154 .05194 .05761 .05302 .05054 .04951 .05343 .05056 .05731 .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.49))
MEAN       .70410 .50224 .49476 .50110 .50091 .49716 .49400 .50167 .50023 .49607 .49427 .       .       .       .       .
STD        .03669 .05550 .05039 .04849 .05410 .04902 .05016 .04060 .05215 .05200 .05525 .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.49))
MEAN       .70410 .50224 .49476 .50110 .50091 .49716 .49400 .50167 .50023 .49607 .49427 .       .       .       .       .
STD        .03669 .05550 .05035 .04849 .05410 .04902 .05016 .04060 .05215 .05200 .05525 .       .       .       .       .


                                          TABLE A3.208

                                  ESTIMATION OF PARAMETERS FOR
                      NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  4    K=0.70
                                         ---                      --         --     ----

PARAMETER  K       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
           ------------------------------------------------------------------------------------------------------------------------
VALUES     0.70    0.10    0.15    0.20    0.25    0.30    0.40    0.50    0.70    0.80    0.85     .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (SPEARMAN, # OF REP: 100)
MEAN       .69041 .10202 .14573 .19717 .24002 .30059 .40530 .50003 .70360 .80346 .84265 .       .       .       .       .
STD        .04654 .03400 .03940 .04947 .04592 .04802 .05600 .05509 .04009 .03791 .03638 .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.60), S.S. RESIDUAL:.00666(SD:.00100))
MEAN       .69811 .10230 .14519 .19661 .24046 .29906 .40522 .49905 .70415 .80325 .84241 .       .       .       .       .
STD        .04620 .03394 .03911 .04927 .04479 .04030 .05594 .05474 .04000 .03357 .03656 .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.42))
MEAN       .69060 .10299 .14501 .19724 .24049 .30045 .40602 .50022 .70454 .80277 .84219 .       .       .       .       .
STD        .04514 .03300 .03943 .04900 .04404 .04036 .05466 .05403 .04753 .03735 .03636 .       .       .       .       .
           ------------------------------------------------------------------------------------------------------------------------
           (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.4(SD: 0.24))
MEAN       .69060 .10299 .14501 .19724 .24049 .30045 .40602 .50022 .70454 .80277 .84219 .       .       .       .       .
STD        .04514 .03300 .03943 .04900 .04404 .04036 .05466 .05403 .04753 .03735 .03636 .       .       .       .       .
```

TABLE A3.209

```
                         ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  5    K=0.70
                              ---                    --         --     ----

PARAMETER  K       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          --------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45     .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69347 .34726 .24833 .40056 .20008 .10098 .05321 .49902 .30172 .15120 .45452 .      .      .      .      .
STD       .04011 .05313 .04299 .04929 .04520 .03604 .02646 .05593 .04992 .03931 .06291 .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.60), S.S. RESIDUAL:.00607(SD:.00101))
MEAN      .69334 .34739 .24825 .40028 .20004 .10076 .05306 .49902 .30134 .15114 .45439 .      .      .      .      .
STD       .03997 .05339 .04296 .04893 .04490 .03503 .02654 .05579 .04950 .03903 .06272 .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.10))
MEAN      .69375 .34961 .24956 .39981 .20089 .10090 .05291 .49987 .30154 .15113 .45406 .      .      .      .      .
STD       .03996 .05315 .04316 .04792 .04399 .03494 .02554 .05490 .04750 .03954 .06251 .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.40))
MEAN      .69375 .34961 .24956 .39981 .20089 .10090 .05291 .49987 .30159 .15113 .45406 .      .      .      .      .
STD       .03996 .05315 .04316 .04792 .04399 .03494 .02554 .05490 .04750 .03954 .06251 .      .      .      .      .
```

TABLE A3.210

```
                         ESTIMATION OF PARAMETERS FOR
           NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET  6    K=0.70
                              ---                    --         --     ----

PARAMETER  K       B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                    1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          --------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55     .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70402 .64080 .74987 .61062 .80010 .90129 .94909 .50371 .69984 .84740 .55199 .      .      .      .      .
STD       .04721 .05721 .05274 .06157 .04009 .03557 .02429 .07151 .06312 .03300 .06234 .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.1(SD: 1.00), S.S. RESIDUAL:.00691(SD:.00154))
MEAN      .70199 .64853 .74175 .60089 .80660 .90040 .94874 .49916 .69009 .84633 .55167 .      .      .      .      .
STD       .04596 .05553 .04947 .05709 .04732 .03516 .02311 .06911 .06161 .03593 .06104 .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 7.0(SD: 1.26))
MEAN      .70242 .65046 .74492 .60011 .80592 .90000 .94890 .49770 .69984 .84507 .55149 .      .      .      .      .
STD       .04406 .05139 .04609 .05390 .04624 .03410 .02222 .06402 .05561 .03521 .05940 .      .      .      .      .
          --------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.52))
MEAN      .70242 .65046 .74492 .60011 .80592 .90000 .94890 .49770 .69984 .84507 .55149 .      .      .      .      .
STD       .04406 .05139 .04609 .05390 .04624 .03410 .02222 .06402 .05561 .03521 .05940 .      .      .      .      .
```

```
                                          TABLE A3.211

                                   ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    # SET  7    K=0.70
                                       ---                    --          --    ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70036 .19242 .20143 .20169 .20137 .19961 .19797 .19998 .20510 .19843 .20304 .19994 .20357 .19985 .20360 .20085
STD       .04096 .03964 .04136 .03970 .04295 .04204 .04668 .04641 .04969 .04324 .04556 .04093 .04254 .04193 .04505 .04535
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.1(SD: 0.67), S.S. RESIDUAL:.01302(SD:.00223))
MEAN      .70031 .19241 .20140 .20160 .20136 .19952 .19790 .19993 .20512 .19836 .20372 .19994 .20353 .19976 .20357 .20076
STD       .04099 .03961 .04136 .03974 .04302 .04282 .04667 .04645 .04979 .04319 .04542 .04092 .04252 .04187 .04505 .04514
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .70017 .19267 .20185 .20125 .20157 .19867 .19789 .19979 .20449 .19855 .20339 .19987 .20206 .19888 .20361 .20012
STD       .04058 .03980 .04176 .03995 .04282 .04124 .04672 .04870 .04959 .04297 .04491 .04071 .04204 .04065 .04426 .04501
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.5(SD: 0.50))
MEAN      .70017 .19267 .20185 .20125 .20157 .19867 .19789 .19979 .20449 .19855 .20339 .19987 .20206 .19888 .20361 .20012
STD       .04058 .03980 .04176 .03995 .04282 .04124 .04672 .04870 .04959 .04297 .04491 .04071 .04204 .04065 .04426 .04501
```

```
                                          TABLE A3.212

                                   ESTIMATION OF PARAMETERS FOR
                    NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    # SET  8    K=0.70
                                       ---                    --          --    ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69059 .40244 .39683 .39879 .39871 .40317 .40019 .40402 .39470 .40077 .40002 .40026 .40434 .39776 .40147 .40591
STD       .04327 .05310 .05623 .05587 .05499 .05519 .05333 .04656 .05772 .05686 .05089 .05277 .05410 .05712 .05409 .05699
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.91), S.S. RESIDUAL:.01065(SD:.00504))
MEAN      .69014 .40269 .39671 .39843 .39840 .40291 .40777 .40369 .39411 .40050 .40790 .39902 .40190 .39738 .40114 .40591
STD       .04319 .05300 .05611 .05582 .05461 .05492 .05327 .04633 .05711 .05503 .05003 .05277 .05307 .05693 .04991 .05702
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .69842 .40287 .39901 .39945 .39819 .40319 .40601 .40140 .39409 .39970 .40060 .39969 .40391 .39636 .40095 .40086
STD       .04281 .05334 .05437 .05532 .05090 .05342 .05297 .04640 .05620 .05510 .05150 .05234 .05257 .05403 .04849 .05751
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.38))
MEAN      .69842 .40287 .39901 .39945 .39819 .40319 .40601 .40140 .39409 .39970 .40060 .39969 .40391 .39636 .40095 .40086
STD       .04281 .05334 .05437 .05532 .05090 .05342 .05297 .04640 .05620 .05510 .05150 .05234 .05257 .05403 .04849 .05751
```

```
                                          TABLE A3.213

                                  ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET  9    R=0.70
                                     ---                     --         --      ----

PARAMETER  R      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                   1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50    0.50
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70436 .50975 .50455 .49895 .50190 .50369 .50068 .50249 .49911 .50494 .50710 .49809 .49670 .50493 .50256 .49921
STD       .04590 .05967 .05402 .05271 .06222 .05462 .05272 .05359 .05412 .05013 .05748 .05644 .05003 .05733 .05150 .06069
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.70), S.S. RESIDUAL:.03399(SD:.00473))
MEAN      .70340 .50463 .50400 .49087 .50121 .50299 .50011 .50102 .49813 .50473 .50622 .49762 .49609 .49973 .50197 .49882
STD       .04594 .05945 .05159 .05242 .06186 .05461 .05213 .05320 .05383 .04995 .05710 .05590 .05757 .05712 .05133 .06071
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.43))
MEAN      .70427 .50939 .50400 .49392 .50045 .50214 .50194 .50210 .49894 .50674 .50394 .49806 .49649 .49970 .50219 .49902
STD       .04461 .05092 .05244 .05114 .05049 .05255 .04902 .05217 .05374 .04851 .05648 .05353 .05615 .05504 .04950 .05983
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.17))
MEAN      .70427 .50939 .50400 .49392 .50045 .50214 .50194 .50210 .49894 .50674 .50394 .49806 .49649 .49970 .50219 .49902
STD       .04461 .05092 .05244 .05114 .05049 .05255 .04902 .05217 .05374 .04851 .05648 .05353 .05615 .05504 .04950 .05983


                                          TABLE A3.214

                                  ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET 10    R=0.70
                                     ---                     --         --      ----

PARAMETER  R      B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                   1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.70   0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.55    0.60    0.65    0.70    0.80    0.85
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .70130 .09003 .14713 .20217 .24636 .30195 .35687 .40311 .45400 .50080 .55226 .60015 .64318 .70331 .79770 .84641
STD       .04006 .02854 .04197 .04741 .04424 .04822 .04994 .05626 .05017 .05706 .05391 .06157 .05050 .05520 .04421 .03949
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.9(SD: 0.67), S.S. RESIDUAL:.02054(SD:.00360))
MEAN      .70090 .09798 .14709 .20240 .24643 .30167 .35686 .40293 .45317 .50023 .55154 .60030 .64371 .70273 .79725 .84546
STD       .04098 .02030 .04148 .04702 .04367 .04722 .04929 .05624 .05307 .05723 .05314 .06216 .05794 .05503 .04387 .03920
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .70117 .09706 .14753 .20375 .24791 .30111 .35701 .40333 .45223 .50645 .55211 .60050 .64441 .70219 .79795 .84614
STD       .03989 .02049 .04200 .04665 .04201 .04607 .04787 .05496 .05730 .05607 .05331 .06263 .05768 .05352 .04260 .03902
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.29))
MEAN      .70117 .09706 .14753 .20375 .24791 .30111 .35701 .40333 .45223 .50645 .55211 .60050 .64441 .70219 .79795 .84614
STD       .03989 .02049 .04200 .04665 .04201 .04607 .04787 .05496 .05730 .05607 .05331 .06263 .05768 .05352 .04260 .03902
```

```
                                    TABLE A1.215

                           ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET 11    A=0.70
                                 ---                    --           --     ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.10    0.15    0.20    0.25    0.30    0.35    0.40    0.45    0.50    0.05    0.15    0.25    0.45    0.45    0.25
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69918 .09477 .14715 .20901 .24632 .29425 .33195 .40270 .45992 .50661 .04701 .14709 .25350 .35060 .45153 .24654
STD       .04095 .01222 .03036 .04188 .04589 .04812 .04991 .05425 .05297 .05660 .02305 .03970 .05000 .05716 .05007 .05395
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.0(SD: 0.50), S.S. RESIDUAL:.01009(SD:.00369))
MEAN      .69913 .09482 .14697 .20095 .24629 .29420 .33772 .40202 .45974 .50700 .04698 .14703 .25346 .35024 .45142 .24651
STD       .04102 .01226 .03012 .04160 .04580 .04817 .04970 .05420 .05311 .05646 .02294 .03970 .05007 .05705 .05791 .05394
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .69892 .09447 .14671 .20047 .24532 .29365 .33604 .40342 .45940 .50609 .04671 .14690 .25357 .35701 .45100 .24671
STD       .04097 .01214 .03724 .04376 .04569 .04827 .05033 .05433 .05327 .05434 .02266 .03973 .05001 .05609 .05727 .05344
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.44))
MEAN      .69892 .09447 .14671 .20047 .24532 .29365 .33604 .40342 .45940 .50609 .04671 .14690 .25357 .35701 .45100 .24671
STD       .04097 .01214 .03724 .04376 .04569 .04827 .05033 .05433 .05327 .05434 .02266 .03973 .05001 .05609 .05727 .05344
```

```
                                    TABLE A1.216

                           ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    B SET 12    A=0.70
                                 ---                    --           --     ----

PARAMETER  A       B       B       B       B       B       B       B       B       B       B       B       B       B       B       B
                    1       2       3       4       5       6       7       8       9       10      11      12      13      14      15
          ------------------------------------------------------------------------------------------------------------------------------
VALUES    0.70    0.90    0.05    0.80    0.75    0.70    0.65    0.60    0.55    0.50    0.95    0.05    0.75    0.55    0.55    0.75
          ------------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .69699 .89009 .04447 .81201 .74660 .69593 .65909 .60086 .54490 .49306 .95450 .04813 .75192 .65203 .54646 .75111
STD       .04060 .01623 .03937 .04160 .04599 .05460 .05761 .05570 .0555[illegible] .06197 .02403 .04076 .05146 .05052 .07008 .04957
          ------------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.65), S.S. RESIDUAL:.01029(SD:.00314))
MEAN      .69323 .89658 .04[illegible]07 .80958 .74599 .69410 .65676 .59939 .54250 .49356 .95303 .04701 .75020 .65000 .54613 .74882
STD       .04093 .01520 .01961 .04059 .04535 .05297 .05493 .05580 .05389 .06492 .02197 .03947 .05012 .05777 .06935 .04650
          ------------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.6(SD: 0.53))
MEAN      .69715 .89021 .04430 .80811 .74829 .69405 .65600 .60309 .54605 .49619 .95376 .04701 .75339 .65257 .54723 .74921
STD       .03022 .01147 .01905 .03039 .04200 .05045 .05246 .05165 .04920 .05032 .02202 .03012 .04024 .05529 .06776 .04221
          ------------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.7(SD: 0.50))
MEAN      .69729 .89023 .04441 .80834 .74833 .69491 .65614 .60317 .54615 .49629 .95376 .04704 .75343 .65264 .54712 .74929
STD       .03021 .01146 .01905 .01001 .04201 .05047 .05253 .05166 .04908 .05072 .02202 .03012 .04025 .05531 .06770 .04215
```

```
                                        TABLE A3.217

                              ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  1    R-0.75
                                     ---                    --          --    ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20     .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74627 .20272 .20733 .19970 .20199 .19351 .19463 .19670 .20607 .19926 .20596 .       .       .       .       .
STD       .03712 .04290 .04333 .04615 .04055 .03057 .03561 .04419 .04502 .04517 .04299 .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.3(SD: 0.61), S.S. RESIDUAL:.00607(SD:.00169))
MEAN      .74610 .20266 .20734 .19966 .20192 .19142 .19442 .19667 .20593 .19921 .20584 .       .       .       .       .
STD       .03717 .04209 .04334 .04616 .04047 .03051 .03556 .04406 .04503 .04503 .04289 .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (GUNNMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .74642 .20318 .20767 .19935 .20200 .19264 .19496 .19676 .20451 .19914 .20611 .       .       .       .       .
STD       .03731 .04226 .04380 .04600 .04035 .03899 .03526 .04345 .04484 .04356 .04319 .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.6(SD: 0.50))
MEAN      .74642 .20318 .20767 .19935 .20200 .19264 .19496 .19676 .20451 .19914 .20611 .       .       .       .       .
STD       .03731 .04226 .04380 .04600 .04035 .03899 .03526 .04345 .04484 .04356 .04319 .       .       .       .       .


                                        TABLE A3.218

                              ESTIMATION OF PARAMETERS FOR
                  NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    # SET  2    R=0.75
                                     ---                    --          --    ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40     .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75190 .39562 .39793 .40013 .41230 .41191 .39591 .39503 .40156 .40409 .39710 .       .       .       .       .
STD       .03964 .04620 .04953 .05338 .05421 .05329 .04709 .05133 .05385 .05500 .04677 .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.69), S.S. RESIDUAL:.01130(SD:.00276))
MEAN      .75123 .39536 .39729 .39970 .41200 .41175 .39506 .39532 .40874 .40352 .39658 .       .       .       .       .
STD       .03940 .04616 .04910 .05312 .05369 .05318 .04740 .05100 .05355 .05404 .04629 .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (GUNNMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.27))
MEAN      .75150 .39740 .39650 .40006 .41193 .41223 .39050 .39427 .39562 .40263 .39563 .       .       .       .       .
STD       .03945 .04393 .04879 .05223 .05126 .05291 .04422 .05009 .05076 .05294 .04338 .       .       .       .       .
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.39))
MEAN      .75150 .39740 .39650 .40006 .41193 .41223 .39050 .39427 .39562 .40263 .39563 .       .       .       .       .
STD       .03945 .04393 .04879 .05223 .05126 .05291 .04422 .05009 .05076 .05294 .04338 .       .       .       .       .
```

```
                                   TABLE A3.219

                           ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET 3    K=0.75
                                  ---                    --          --    ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74966 .49494 .50745 .49807 .50630 .50036 .49707 .49477 .49263 .50336 .49905 .      .      .      .      .
STD       .04374 .05318 .05340 .05607 .05165 .05328 .05127 .05945 .05049 .05507 .05742 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.6(SD: 0.54), S.S. RESIDUAL:.01454(SD:.00341))
MEAN      .74828 .49419 .50655 .49706 .50550 .49894 .49727 .49397 .49185 .50275 .49403 .      .      .      .      .
STD       .04351 .05248 .05315 .05621 .05345 .05233 .05039 .05905 .05789 .05428 .05667 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.5(SD: 0.50))
MEAN      .74837 .49365 .50544 .49638 .50496 .49832 .49820 .49338 .49275 .50280 .49612 .      .      .      .      .
STD       .04129 .04985 .05246 .05264 .05322 .05152 .04941 .05698 .05531 .05303 .05317 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.3(SD: 0.44))
MEAN      .74837 .49365 .50544 .49638 .50496 .49832 .49820 .49338 .49275 .50280 .49612 .      .      .      .      .
STD       .04129 .04985 .05246 .05264 .05322 .05152 .04941 .05698 .05531 .05303 .05317 .      .      .      .      .


                                   TABLE A3.220

                           ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    B SET 4    K=0.75
                                  ---                    --          --    ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                  1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75358 .10733 .15226 .19771 .24997 .30350 .40264 .50021 .69504 .80048 .85008 .      .      .      .      .
STD       .04234 .03243 .04216 .04023 .04569 .04875 .05407 .05480 .04481 .03595 .04853 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.3(SD: 0.64), S.S. RESIDUAL:.00747(SD:.00184))
MEAN      .75325 .10729 .15243 .19797 .25054 .30255 .40187 .49968 .69548 .80769 .84989 .      .      .      .      .
STD       .04220 .03170 .04185 .04801 .04497 .04833 .05358 .05434 .04457 .03635 .04028 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.7(SD: 0.46))
MEAN      .75318 .10645 .15235 .19778 .25106 .30360 .40102 .49849 .69597 .80633 .85106 .      .      .      .      .
STD       .04372 .03181 .04101 .04693 .04269 .04803 .05365 .05346 .04491 .03623 .04808 .      .      .      .      .
          -------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.35))
MEAN      .75318 .10645 .15235 .19778 .25106 .30360 .40102 .49849 .69597 .80633 .85106 .      .      .      .      .
STD       .04372 .03181 .04101 .04693 .04269 .04803 .05365 .05346 .04491 .03623 .04808 .      .      .      .      .
```

TABLE A3.221

```
                         ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    R SET  5    A=0.75
                             ---                    --         --     ----

PARAMETER  A       R       R       R       R       R       R       R       R       R       R       R       R       R       R       R
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.35    0.25    0.40    0.20    0.10    0.05    0.50    0.30    0.15    0.45     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74839 .33920 .25471 .40020 .19509 .09032 .05290 .49958 .30134 .14865 .45591 .       .       .       .       .
STD       .03910 .04253 .04410 .04852 .04205 .03290 .02600 .04951 .04404 .04019 .04985 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.4(SD: 0.55), S.S. RESIDUAL:.00741(SD:.00213))
MEAN      .74010 .33929 .25432 .40010 .19497 .09029 .05291 .49924 .30110 .14862 .45504 .       .       .       .       .
STD       .03885 .04257 .04377 .04843 .04241 .03294 .02685 .04969 .04851 .03999 .05002 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.10))
MEAN      .74033 .33893 .25452 .40016 .19509 .09017 .05290 .49943 .30032 .14956 .45595 .       .       .       .       .
STD       .03862 .04332 .04329 .04828 .04154 .03284 .02594 .05019 .04709 .03960 .04892 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.49))
MEAN      .74033 .33893 .25452 .40016 .19509 .09017 .05290 .49943 .30032 .14956 .45595 .       .       .       .       .
STD       .03862 .04332 .04329 .04828 .04154 .03284 .02594 .05019 .04709 .03960 .04892 .       .       .       .       .
```

TABLE A3.222

```
                         ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    R SET  6    A=0.75
                             ---                    --         --     ----

PARAMETER  A       R       R       R       R       R       R       R       R       R       R       R       R       R       R       R
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          -------------------------------------------------------------------------------------------------------------------------
VALUES    0.75    0.65    0.75    0.60    0.80    0.90    0.95    0.50    0.70    0.85    0.55     .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74609 .65193 .74699 .60351 .80535 .89251 .95147 .49870 .70579 .84921 .55466 .       .       .       .       .
STD       .04942 .05309 .04476 .06272 .05177 .03435 .02537 .05958 .04403 .04209 .05194 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.3(SD: 1.14), S.S. RESIDUAL:.00745(SD:.00176))
MEAN      .74153 .64911 .74560 .60107 .80200 .89149 .95070 .49701 .70473 .84849 .55010 .       .       .       .       .
STD       .04965 .05490 .04015 .06252 .05307 .03311 .02308 .05604 .04256 .04001 .05222 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 8.1(SD: 1.24))
MEAN      .74465 .64980 .74649 .60176 .80192 .89208 .95007 .50056 .70411 .84902 .55249 .       .       .       .       .
STD       .04330 .04644 .03946 .05879 .05156 .03227 .02281 .05441 .04190 .03853 .05400 .       .       .       .       .
          -------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.3(SD: 0.60))
MEAN      .74465 .64980 .74649 .60176 .80192 .89208 .95007 .50056 .70411 .84902 .55249 .       .       .       .       .
STD       .04330 .04644 .03946 .05879 .05156 .03227 .02281 .05441 .04190 .03853 .05400 .       .       .       .       .
```

```
                                   TABLE A3.223

                           ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    # SET  7    R=0.75
                                   ---                    --          --     ----

PARAMETER  R      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          --------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20
          --------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75056 .19513 .20243 .19946 .20056 .20072 .20039 .19567 .20663 .20369 .19416 .19808 .20079 .20713 .20486 .20449
STD       .04126 .04239 .04048 .03536 .04340 .04045 .03780 .04420 .04526 .04636 .04494 .04655 .03774 .04538 .04276 .04046
          --------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.1(SD: 0.62), S.S. RESIDUAL:.01496(SD:.00250))
MEAN      .75049 .19508 .20236 .19940 .20042 .20066 .20005 .19560 .20665 .20162 .19413 .19879 .20076 .20729 .20478 .20395
STD       .04128 .04269 .04049 .03913 .04332 .04048 .03778 .04416 .04518 .04636 .04498 .04655 .03772 .04527 .04275 .04045
          --------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75000 .19428 .20065 .19834 .19944 .20058 .20752 .19556 .20651 .20204 .19360 .19870 .20060 .20603 .20402 .20344
STD       .04129 .04192 .04065 .03869 .04287 .04029 .03740 .04347 .04510 .04558 .04510 .04619 .03739 .04463 .04323 .03998
          --------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.4(SD: 0.49))
MEAN      .75000 .19428 .20065 .19834 .19944 .20058 .20752 .19556 .20651 .20204 .19360 .19870 .20060 .20603 .20402 .20344
STD       .04129 .04192 .04065 .03869 .04287 .04029 .03740 .04347 .04510 .04558 .04510 .04619 .03739 .04463 .04323 .03998


                                   TABLE A3.224

                           ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    # SET  8    R=0.75
                                   ---                    --          --     ----

PARAMETER  R      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          --------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40
          --------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75571 .39621 .38884 .39602 .39666 .39337 .39969 .39800 .39389 .38756 .39504 .39513 .39225 .40689 .39515 .39550
STD       .04174 .05687 .04965 .05037 .04681 .05620 .05385 .05635 .04881 .05032 .05246 .05132 .05276 .05462 .04787 .05032
          --------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.0(SD: 0.49), S.S. RESIDUAL:.03382(SD:.00490))
MEAN      .75525 .39584 .38860 .39572 .39632 .39884 .39930 .39763 .39305 .38747 .39489 .39500 .39193 .40627 .39490 .39506
STD       .04170 .05668 .04940 .05009 .04673 .05596 .05159 .05636 .04848 .05019 .05234 .05131 .05254 .05447 .04760 .05015
          --------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75600 .39517 .38926 .39530 .39752 .39186 .39971 .39745 .39617 .38847 .39556 .39615 .39228 .40477 .39606 .39577
STD       .04178 .05565 .04860 .04823 .04486 .05419 .04907 .05603 .04745 .04858 .05191 .05012 .05081 .05467 .04718 .04864
          --------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.1(SD: 0.30))
MEAN      .75600 .39517 .38926 .39530 .39752 .39186 .39971 .39745 .39617 .38847 .39556 .39615 .39220 .40477 .39606 .39577
STD       .04178 .05565 .04860 .04823 .04486 .05419 .04907 .05603 .04745 .04858 .05191 .05012 .05081 .05467 .04718 .04864
```

```
                                   TABLE A3.225

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    A SET  9    K=0.75
                                 ---                    --         --     ----

PARAMETER  K      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74780 .50071 .49490 .50115 .49926 .49557 .50113 .49656 .49961 .50720 .49112 .50013 .50394 .49029 .49757 .49982
STD       .03021 .05873 .04910 .06236 .05547 .05532 .05048 .05429 .05776 .06419 .05363 .05775 .05350 .05412 .05434 .06450
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.4(SD: 0.61), S.S. RESIDUAL:.03502(SD:.00502))
MEAN      .74697 .50045 .49461 .50248 .49536 .49487 .50033 .49594 .49901 .50676 .49252 .49937 .50333 .49002 .49720 .49950
STD       .03022 .05044 .04870 .06253 .05567 .05509 .05031 .05412 .05750 .06374 .05355 .05742 .05322 .05412 .05392 .06461
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.35))
MEAN      .74819 .50160 .49566 .50161 .50284 .49509 .49891 .49499 .49965 .50675 .49396 .50010 .50272 .49162 .49895 .50142
STD       .03767 .05638 .04640 .06156 .05463 .05355 .05007 .05339 .05672 .06199 .05189 .05650 .05192 .05312 .04971 .06349
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.1(SD: 0.27))
MEAN      .74819 .50160 .49566 .50161 .50284 .49509 .49891 .49499 .49965 .50675 .49396 .50010 .50272 .49162 .49895 .50142
STD       .03767 .05638 .04640 .06156 .05463 .05355 .05007 .05339 .05672 .06199 .05189 .05650 .05192 .05312 .04971 .06349


                                   TABLE A3.226

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    A SET 10    K=0.75
                                 ---                    --         --     ----

PARAMETER  K      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75142 .09644 .14519 .19913 .25136 .29925 .35573 .39836 .44829 .50059 .54815 .60189 .65096 .70394 .79506 .85493
STD       .04061 .03407 .04116 .04503 .04530 .04740 .05044 .05036 .05020 .05447 .05366 .05282 .04901 .04503 .04350 .01875
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.61), S.S. RESIDUAL:.02225(SD:.00363))
MEAN      .75121 .09615 .14485 .19962 .25008 .29984 .35614 .39770 .44822 .50012 .54838 .60162 .65060 .70363 .79554 .85450
STD       .04055 .03350 .04081 .04500 .04494 .04754 .05046 .05110 .04988 .05456 .05275 .05240 .04835 .04464 .04313 .03068
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75075 .09631 .14355 .19815 .25010 .29908 .35441 .39765 .44811 .50026 .54834 .60099 .65058 .70407 .79501 .85479
STD       .04000 .03315 .04055 .04443 .04434 .04747 .04914 .05011 .04864 .05339 .05253 .05219 .04654 .04213 .04293 .03835
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.41))
MEAN      .75075 .09631 .14355 .19815 .25010 .29908 .35441 .39765 .44811 .50026 .54834 .60099 .65058 .70407 .79501 .85479
STD       .04000 .03315 .04055 .04443 .04434 .04747 .04914 .05011 .04864 .05339 .05253 .05219 .04654 .04213 .04293 .03835
```

```
                              TABLE A3.227

                     ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET 11    K=0.75
                             ---                    --          --      ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.45   0.45   0.25
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .75149 .09991 .15104 .20095 .24737 .29775 .34940 .39308 .44765 .50098 .04924 .14939 .25080 .35016 .45630 .25119
STD       .04161 .03122 .03721 .04124 .04502 .04846 .04941 .04749 .05758 .05217 .02433 .03695 .03759 .05242 .05364 .04313
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.37), S.S. RESIDUAL:.01965(SD:.00330))
MEAN      .75149 .09952 .15096 .20100 .24713 .29774 .34960 .39301 .44769 .50037 .04915 .14940 .25050 .35037 .45648 .25095
STD       .04166 .03123 .03701 .04651 .04502 .04809 .04876 .04745 .05770 .05212 .02427 .03670 .03757 .05260 .05347 .04080
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .75192 .10027 .15194 .20106 .24837 .29814 .35102 .39412 .44872 .50004 .04866 .14915 .25015 .35069 .45601 .25136
STD       .04184 .03173 .03625 .04545 .04420 .04752 .04757 .04697 .05743 .05160 .02387 .03516 .03794 .05189 .05309 .04753
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.45))
MEAN      .75192 .10027 .15194 .20106 .24837 .29814 .35102 .39412 .44872 .50004 .04866 .14915 .25015 .35069 .45601 .25136
STD       .04184 .03173 .03625 .04545 .04420 .04752 .04757 .04697 .05743 .05160 .02387 .03516 .03794 .05189 .05309 .04753


                              TABLE A3.228

                     ESTIMATION OF PARAMETERS FOR
          NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET 12    K=0.75
                             ---                    --          --      ----

PARAMETER  K      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.75   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.05   0.75   0.55   0.55   0.75
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .74835 .89912 .85101 .80454 .75155 .69629 .65450 .58956 .54857 .50040 .95103 .05243 .75019 .65267 .54671 .75660
STD       .04752 .03652 .03451 .04412 .05429 .05140 .04960 .05776 .05369 .05520 .02346 .03412 .04743 .05650 .05023 .04530
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.2(SD: 0.64), S.S. RESIDUAL:.01979(SD:.00371))
MEAN      .74397 .89835 .85013 .80419 .75059 .69320 .65151 .58059 .54750 .49637 .95056 .05071 .74843 .65017 .54998 .75619
STD       .04917 .03564 .03744 .04644 .05282 .05012 .04813 .05585 .05121 .05301 .02271 .01277 .04559 .05570 .05797 .04434
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.6(SD: 0.59))
MEAN      .74716 .89798 .85044 .80487 .75369 .69217 .65261 .59071 .55132 .49631 .95023 .04900 .74912 .65323 .54714 .75501
STD       .04542 .01442 .03595 .04420 .05099 .04739 .04611 .05249 .05030 .04808 .02241 .01230 .04273 .05253 .05196 .04192
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.1(SD: 0.36))
MEAN      .74719 .89798 .85044 .80440 .75170 .69219 .65263 .59073 .55134 .49633 .95023 .04909 .74911 .65325 .54716 .75502
STD       .04545 ,01442 .03596 .04420 .05096 .04739 .04610 .05245 .05069 .04890 .02241 .01239 .04274 .05253 .05192 .04191
```

```
                                    TABLE A3.229

                             ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    A SET  1    B=0.00
                                   ---                    --          --    ----

PARAMETER  B      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20   0.20    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00094 .20736 .19718 .20156 .19879 .20003 .19785 .20003 .20596 .19426 .19174 .      .      .      .      .
STD       .03606 .03751 .03948 .03975 .04129 .04169 .04377 .03755 .03936 .04029 .03812 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.3(SD: 0.57), S.S. RESIDUAL:.00615(SD:.00158))
MEAN      .00081 .20729 .19708 .20141 .19871 .19995 .19777 .19995 .20579 .19423 .19167 .      .      .      .      .
STD       .03606 .03749 .03941 .03975 .04122 .04160 .04373 .03743 .03912 .04029 .03820 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .00058 .20728 .19701 .20080 .19055 .19905 .19703 .19909 .20530 .19385 .19230 .      .      .      .      .
STD       .03595 .03795 .03808 .03808 .04015 .04014 .04336 .03636 .03892 .03860 .03833 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.5(SD: 0.50))
MEAN      .00058 .20728 .19701 .20080 .19055 .19905 .19703 .19909 .20530 .19385 .19230 .      .      .      .      .
STD       .03595 .03795 .03808 .03804 .04015 .04014 .04336 .03636 .03892 .03860 .03833 .      .      .      .      .


                                    TABLE A3.230

                             ESTIMATION OF PARAMETERS FOR
                NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    A SET  2    B=0.00
                                   ---                    --          --    ----

PARAMETER  B      A      A      A      A      A      A      A      A      A      A      A      A      A      A      A
                   1      2      3      4      5      6      7      8      9     10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40   0.40    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00118 .39022 .40210 .39940 .39294 .40436 .39268 .38973 .39174 .35616 .40164 .      .      .      .      .
STD       .03999 .05747 .05695 .05419 .05407 .04994 .05174 .04913 .05018 .04920 .04913 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.61), S.S. RESIDUAL:.01400(SD:.00100))
MEAN      .00058 .39701 .40135 .39805 .39266 .40401 .39255 .38996 .39151 .39574 .40126 .      .      .      .      .
STD       .03991 .05712 .05636 .05406 .05379 .04971 .05161 .04906 .05016 .04933 .04863 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.29))
MEAN      .79999 .39705 .39865 .39719 .39178 .40515 .39304 .39011 .39136 .39496 .40011 .      .      .      .      .
STD       .03914 .05501 .05242 .05201 .05223 .04863 .04969 .04693 .05054 .04964 .04626 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.3(SD: 0.47))
MEAN      .79999 .39705 .39845 .39719 .39178 .40515 .39304 .39011 .39136 .39496 .40011 .      .      .      .      .
STD       .03914 .05501 .05262 .05201 .05223 .04863 .04969 .04693 .05050 .04964 .04626 .      .      .      .      .
```

```
                                        TABLE A3.231

                                ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    E SET  3    R=0.80
                                      ---                    --         --      ----

PARAMETER  R      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79831 .49975 .50506 .49178 .50267 .50003 .50067 .50261 .50201 .49708 .50193 .      .      .      .      .
STD       .04898 .05142 .04971 .05235 .05727 .05540 .04832 .04959 .05220 .05489 .05146 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.7(SD: 0.51), S.S. RESIDUAL:.01543(SD:.00363))
MEAN      .79703 .49806 .50420 .49354 .50159 .49976 .49997 .50237 .50074 .49744 .50085 .      .      .      .      .
STD       .04093 .05110 .04927 .05143 .05651 .05401 .04814 .04872 .05170 .05353 .05000 ..     .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.6(SD: 0.49))
MEAN      .79837 .49703 .50420 .49525 .50096 .50165 .50249 .50492 .49904 .49964 .50004 .      .      .      .      .
STD       .03932 .04969 .04834 .05017 .05429 .05159 .04697 .04708 .04996 .05042 .04939 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.3(SD: 0.48))
MEAN      .79837 .49703 .50420 .49525 .50096 .50165 .50249 .50492 .49904 .49964 .50004 .      .      .      .      .
STD       .03932 .04969 .04834 .05017 .05429 .05159 .04697 .04708 .04996 .05042 .04939 .      .      .      .      .
```

```
                                        TABLE A3.232

                                ESTIMATION OF PARAMETERS FOR
                   NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    E SET  4    R=0.80
                                      ---                    --         --      ----

PARAMETER  R      E      E      E      E      E      E      E      E      E      E      E      E      E      E      E
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ------------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.40   0.50   0.70   0.80   0.85    .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .80072 .10264 .15054 .20294 .25298 .31252 .39831 .50097 .69673 .80032 .84755 .      .      .      .      .
STD       .01594 .01103 .01007 .01431 .04966 .05204 .05117 .04603 .04798 .03902 .03942 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 3.2(SD: 0.62), S.S. RESIDUAL:.00399(SD:.00199))
MEAN      .80063 .10249 .15031 .20284 .25329 .31178 .39754 .50122 .69698 .80030 .84758 .      .      .      .      .
STD       .01598 .01261 .01029 .01452 .04073 .05038 .05090 .04503 .04817 .03919 .03909 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.9(SD: 0.35))
MEAN      .80127 .10297 .15159 .20315 .25424 .31142 .39746 .50157 .69779 .80060 .84796 .      .      .      .      .
STD       .01514 .01146 .01507 .01106 .04505 .05000 .04954 .04402 .04775 .03766 .03805 .      .      .      .      .
          ------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.9(SD: 0.26))
MEAN      .80127 .10297 .15159 .20315 .25424 .31142 .39746 .50157 .69779 .80060 .84796 .      .      .      .      .
STD       .01514 .01146 .01507 .01106 .04505 .05000 .04954 .04402 .04775 .03766 .03805 .      .      .      .      .
```

```
                                   TABLE A3.233

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    X SET  5    R=0.00
                                 ---                    --         --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.35   0.25   0.40   0.20   0.10   0.05   0.50   0.30   0.15   0.45    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00257 .35141 .25286 .39664 .20027 .09636 .05125 .49200 .30761 .14563 .44519 .      .      .      .      .
STD       .03722 .05106 .05072 .05607 .03739 .02764 .02578 .04943 .04719 .03738 .04933 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 6.3(SD: 0.57), S.S. RESIDUAL:.00705(SD:.00197))
MEAN      .00232 .35313 .25243 .39641 .20017 .09606 .05211 .49235 .30800 .14533 .44490 .      .      .      .      .
STD       .03723 .05079 .05063 .05648 .03705 .02717 .02565 .04932 .04696 .03717 .04927 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.10))
MEAN      .00267 .35367 .25140 .39632 .20158 .09552 .05200 .49170 .30907 .14649 .44500 .      .      .      .      .
STD       .03751 .04923 .04945 .05730 .03669 .02607 .02572 .04770 .04710 .03551 .04892 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.99))
MEAN      .00267 .35367 .25140 .39632 .20158 .09552 .05200 .49170 .30907 .14649 .44500 .      .      .      .      .
STD       .03751 .04923 .04945 .05730 .03669 .02607 .02572 .04770 .04710 .03551 .04892 .      .      .      .      .


                                   TABLE A3.234

                          ESTIMATION OF PARAMETERS FOR
              NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 10    X SET  6    R=0.00
                                 ---                    --         --     ----

PARAMETER  A      B      B      B      B      B      B      B      B      B      B      B      B      B      B      B
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          -----------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.65   0.75   0.60   0.80   0.90   0.95   0.50   0.70   0.85   0.55    .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00030 .65304 .74926 .60270 .79103 .89762 .94845 .49504 .70690 .84999 .54669 .      .      .      .      .
STD       .04966 .04493 .05260 .04716 .04179 .03079 .02013 .05953 .05161 .03701 .05532 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 8.1(SD: 1.05), S.S. RESIDUAL:.00825(SD:.00230))
MEAN      .00641 .65197 .74815 .60103 .79202 .89740 .94835 .49407 .70567 .84890 .54563 .      .      .      .      .
STD       .04699 .04714 .05039 .04516 .03965 .02938 .02637 .05754 .04903 .03616 .05307 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 8.7(SD: 1.31))
MEAN      .01226 .65441 .75018 .60408 .79461 .89783 .94961 .49815 .70660 .84948 .54808 .      .      .      .      .
STD       .04053 .04064 .04896 .04177 .03767 .02869 .02412 .05700 .04743 .03527 .05031 .      .      .      .      .
          -----------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.2(SD: 0.40))
MEAN      .01226 .65441 .75018 .60408 .79461 .89783 .94961 .49815 .70660 .84948 .54808 .      .      .      .      .
STD       .04053 .04064 .04896 .04177 .03767 .02869 .02412 .05700 .04743 .03527 .05031 .      .      .      .      .
```

```
                                      TABLE A3.235

                               ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS 120     NUMBER OF ITEMS 15     X SET  7     R=0.00
                                ---                    --            --     ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.00    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20    0.20
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00220 .20050 .20299 .19973 .19910 .19332 .19851 .20110 .20089 .19901 .20610 .20232 .19407 .19756 .19001 .20543
STD       .03648 .04319 .04361 .04036 .03926 .03657 .04169 .04160 .04185 .04347 .04125 .04174 .04160 .04047 .03803 .04556
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.0(SD: 0.60), S.S. RESIDUAL:.01542(SD:.00274))
MEAN      .00221 .20043 .20293 .19960 .19905 .19329 .19848 .20100 .20076 .19976 .20610 .20221 .19400 .19755 .19070 .20530
STD       .03648 .04313 .04363 .04032 .03924 .03654 .04173 .04169 .04105 .04337 .04114 .04171 .04170 .04045 .03879 .04554
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .00225 .20058 .20299 .19421 .19899 .19313 .19890 .20132 .20077 .19900 .20619 .20203 .19419 .19013 .19120 .20516
STD       .03625 .04281 .04296 .03955 .03885 .03706 .04148 .04200 .04222 .04253 .04006 .04068 .04144 .03951 .03785 .04524
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: [illegible](SD: 0.49))
MEAN      .00225 .20058 .20299 .19421 .19899 .19313 .19890 .20132 .20077 .19900 .20619 .20203 .19419 .19013 .19120 .20516
STD       .03625 .04281 .04296 .03955 .03885 .03706 .04148 .04200 .04222 .04253 .04006 .04068 .04144 .03951 .03785 .04524


                                      TABLE A3.236

                               ESTIMATION OF PARAMETERS FOR
             NUMBER OF SUBJECTS 120     NUMBER OF ITEMS 15     X SET  8     R=0.80
                                ---                    --            --     ----

PARAMETER  R       E       E       E       E       E       E       E       E       E       E       E       E       E       E       E
                    1       2       3       4       5       6       7       8       9      10      11      12      13      14      15
          ---------------------------------------------------------------------------------------------------------------------------
VALUES    0.80    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40    0.40
          ---------------------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79474 .39112 .39811 .40471 .40057 .40507 .39770 .39599 .40316 .39635 .40229 .39272 .39510 .39929 .40423 .40099
STD       .03170 .05310 .05400 .04785 .04788 .05329 .05307 .05191 .05542 .05637 .04674 .05549 .05115 .05615 .05413 .05807
          ---------------------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.47), S.S. RESIDUAL:.01472(SD:.00513))
MEAN      .79419 .39073 .39766 .40445 .40040 .40490 .39764 .39579 .40290 .39604 .40209 .39267 .39493 .39900 .40405 .40069
STD       .03103 .05314 .05476 .04773 .04802 .05322 .05377 .05182 .05510 .05642 .04601 .05544 .05344 .05647 .05320 .05806
          ---------------------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .79600 .39102 .39025 .40195 .40245 .40656 .39945 .39765 .40360 .39613 .40197 .39591 .39601 .40073 .40644 .40053
STD       .03221 .05149 .05427 .04562 .04757 .05290 .05313 .05100 .05444 .05600 .04723 .05195 .05264 .05590 .05119 .05019
          ---------------------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.37))
MEAN      .79600 .39102 .39025 .40195 .40245 .40656 .39945 .39765 .40360 .39613 .40197 .39591 .39601 .40073 .40644 .40053
STD       .03221 .05149 .05427 .04562 .04757 .05290 .05313 .05100 .05444 .05600 .04723 .05195 .05264 .05590 .05119 .05019
```

```
                                     TABLE A3.237

                             ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET  9    K=0.00
                                  ---                    --          --      ----

PARAMETER  K      X      X      X      X      X      X      X      X      X      X      X      X      X      X      X
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.00   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50   0.50
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .00209 .49600 .50264 .49274 .50118 .49913 .50136 .50118 .49605 .49269 .49671 .50667 .50100 .49536 .50293 .49181
STD       .03344 .05455 .05503 .04839 .05136 .04951 .05523 .05665 .05673 .05268 .05104 .05915 .05563 .04855 .06033 .05680
          ---------------------------------------------------------------------------------------------------------------
          (BINNES, # OF REP: 100, AVE # OF ITERATIONS 5.2(SD: 0.59), S.S. RESIDUAL:.03026(SD:.00562))
MEAN      .00121 .49537 .50191 .49255 .50043 .49869 .50275 .50075 .49589 .49237 .49613 .50622 .50114 .49520 .50206 .49181
STD       .03123 .05425 .05441 .04833 .05130 .04805 .05491 .05626 .05642 .05242 .05098 .05985 .05546 .04807 .06005 .05680
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.40))
MEAN      .00216 .49413 .49965 .49441 .49955 .50096 .50333 .50252 .49578 .49379 .49689 .50747 .50068 .49719 .50172 .49154
STD       .03111 .05407 .05135 .04931 .04954 .04566 .05100 .05352 .05468 .05162 .05081 .05739 .05440 .04741 .05746 .05617
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.2(SD: 0.39))
MEAN      .00216 .49413 .49965 .49441 .49955 .50096 .50333 .50252 .49578 .49379 .49689 .50747 .50068 .49719 .50172 .49154
STD       .03111 .05407 .05135 .04931 .04954 .04566 .05100 .05352 .05468 .05162 .05081 .05739 .05440 .04741 .05746 .05617


                                     TABLE A3.238

                             ESTIMATION OF PARAMETERS FOR
               NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET 10    K=0.80
                                  ---                    --          --      ----

PARAMETER  K      X      X      X      X      X      X      X      X      X      X      X      X      X      X      X
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.55   0.60   0.65   0.70   0.80   0.85
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79533 .10914 .15145 .19766 .25114 .28959 .35086 .39403 .44286 .50019 .55116 .58950 .65231 .70220 .80447 .84507
STD       .03394 .03175 .03906 .03805 .03897 .04505 .05389 .04723 .05550 .05037 .05148 .05152 .04487 .04778 .04423 .03881
          ---------------------------------------------------------------------------------------------------------------
          (BINNES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.62), S.S. RESIDUAL:.02198(SD:.00361))
MEAN      .79496 .10909 .15102 .19718 .25049 .28904 .35112 .39407 .44250 .50006 .55112 .58906 .65213 .70201 .80417 .84389
STD       .03776 .03142 .03478 .03919 .03869 .04428 .05239 .04671 .05566 .05034 .05058 .05129 .04394 .04701 .04403 .03799
          ---------------------------------------------------------------------------------------------------------------
          (GOODMAN, # OF REP: 100, AVE # OF ITERATIONS: 3.0(SD: 0.00))
MEAN      .79533 .10464 .15123 .19686 .25054 .29070 .35193 .39403 .44255 .49892 .55509 .59052 .65194 .70115 .80368 .84371
STD       .03737 .03038 .03007 .03025 .03791 .04512 .05169 .04490 .05448 .05041 .04945 .04852 .04428 .04611 .04409 .03632
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.0(SD: 0.34))
MEAN      .79533 .10464 .15123 .19686 .25054 .29070 .35193 .39403 .44255 .49892 .55509 .59052 .65190 .70115 .80368 .84371
STD       .03737 .03038 .03007 .03025 .03791 .04512 .05169 .04490 .05448 .05041 .04945 .04852 .04428 .04611 .04409 .03632
```

```
                                            TABLE A3.239

                                  ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET 11    R=0.80
                                        ---                    --          --      ----

PARAMETER  R      X      X      X      X      X      X      X      X      X      X      X      X      X      X      X
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.10   0.15   0.20   0.25   0.30   0.35   0.40   0.45   0.50   0.05   0.15   0.25   0.35   0.45   0.25
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .79725 .09649 .14369 .19847 .24257 .30678 .35236 .39797 .44828 .49830 .04898 .14959 .25137 .35698 .44711 .25299
STD       .03610 .02963 .03558 .03648 .04511 .04899 .04709 .05431 .05503 .05103 .02102 .03619 .04636 .05302 .04675 .04507
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 5.9(SD: 0.36), S.S. RESIDUAL:.02162(SD:.00365))
MEAN      .79720 .09639 .14348 .19916 .24251 .30654 .35245 .39782 .44809 .49820 .04851 .14959 .25131 .35697 .44723 .25295
STD       .03610 .02945 .03525 .03644 .04512 .04898 .04769 .05406 .05492 .05091 .02092 .03615 .04630 .05352 .04665 .04549
          ---------------------------------------------------------------------------------------------------------------
          (GUTTMAN, # OF REP: 100, AVE # OF ITERATIONS: 2.0(SD: 0.00))
MEAN      .79783 .09646 .14393 .20105 .24394 .30693 .35405 .39796 .44705 .49839 .04864 .15005 .25180 .35725 .44858 .25350
STD       .03604 .02921 .03434 .03635 .04495 .04910 .04711 .05393 .05460 .05130 .02129 .03597 .04690 .05376 .04661 .04513
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.48))
MEAN      .79783 .09646 .14393 .20105 .24394 .30693 .35405 .39796 .44705 .49839 .04864 .15005 .25180 .35725 .44858 .25150
STD       .03604 .02921 .03434 .03635 .04495 .04910 .04711 .05393 .05460 .05130 .02129 .03597 .04690 .05376 .04661 .04513


                                            TABLE A3.240

                                  ESTIMATION OF PARAMETERS FOR
                     NUMBER OF SUBJECTS 120    NUMBER OF ITEMS 15    X SET 12    R=0.80
                                        ---                    --          --      ----

PARAMETER  R      X      X      X      X      X      X      X      X      X      X      X      X      X      X      X
                   1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
          ---------------------------------------------------------------------------------------------------------------
VALUES    0.80   0.90   0.85   0.80   0.75   0.70   0.65   0.60   0.55   0.50   0.95   0.05   0.75   0.65   0.55   0.75
          ---------------------------------------------------------------------------------------------------------------
          (SPEARMAN, # OF REP: 100)
MEAN      .80027 .90130 .84998 .79861 .74767 .68912 .65209 .61068 .53523 .50402 .95229 .04963 .74130 .64326 .54216 .74112
STD       .01771 .02928 .04410 .04576 .04742 .05223 .04961 .05079 .05467 .05615 .02136 .04031 .04950 .04596 .05127 .05416
          ---------------------------------------------------------------------------------------------------------------
          (MINRES, # OF REP: 100, AVE # OF ITERATIONS 7.1(SD: 0.70), S.S. RESIDUAL:.02112(SD:.00341))
MEAN      .79749 .90271 .84801 .79740 .74602 .68792 .65017 .60702 .53120 .50239 .95170 .04948 .74292 .64314 .54115 .74151
STD       .01970 .02846 .04327 .04523 .04648 .04932 .04950 .05001 .05205 .05555 .02073 .03065 .04708 .04403 .04928 .05232
          ---------------------------------------------------------------------------------------------------------------
          (GUTTMAN, # OF REP: 100, AVE # OF ITERATIONS: 4.7(SD: 0.50))
MEAN      .80132 .90192 .84800 .79816 .74761 .69014 .64958 .60213 .53693 .50264 .95144 .05011 .74552 .64390 .54467 .74610
STD       .01557 .02627 .04201 .04414 .04356 .04839 .04822 .04874 .04850 .05222 .02150 .03529 .04316 .04490 .04876 .04906
          ---------------------------------------------------------------------------------------------------------------
          (NEWTON-RAPHSON, # OF REP: 100, AVE # OF ITERATIONS: 5.0(SD: 0.13))
MEAN      .80132 .90192 .84800 .79816 .74761 .69014 .64958 .60213 .53693 .50264 .95144 .05011 .74552 .64390 .54467 .74610
STD       .01557 .02627 .04201 .04414 .04356 .04839 .04822 .04874 .04850 .05222 .02150 .03529 .04316 .04490 .04876 .04906
```